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(52) Domestic classification (Edition J):
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U1S 2272 G4D

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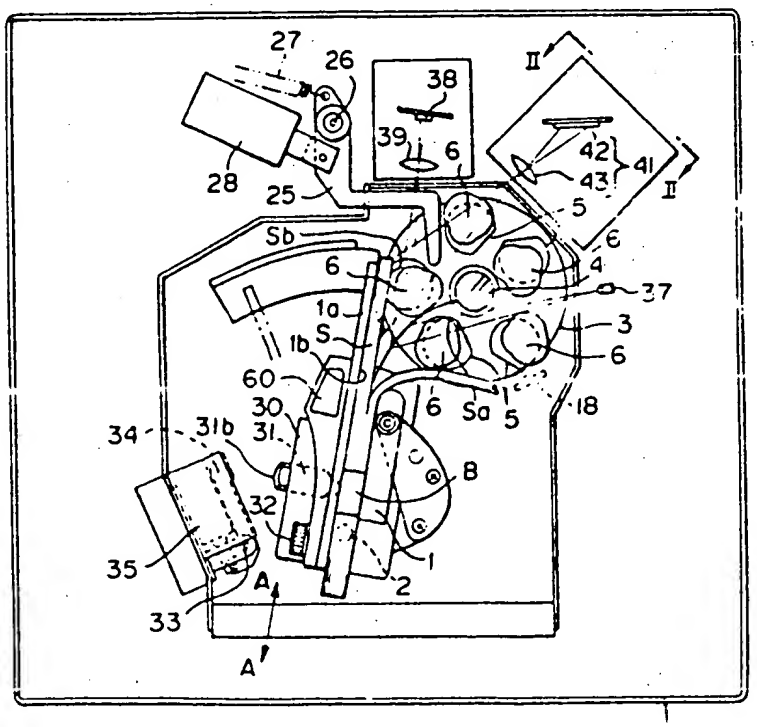
(58) Field of search
G4D
G1A
G4X
Selected US specifications from IPC sub-classes
G01N G06M

(54) Discriminating apparatus for bill counting machine

(57) A discriminating apparatus for a bill counting machine having a holder (1) for holding a stack of bills (S) and suction heads (5) for sucking the bills from the holder and turning over the bills one by one, includes a light projector for emitting a ray of light onto a specified area on the surface of the bill to be discriminated, a photoreceptor (42) for receiving light reflected by the bill while the bill is being turned over by one of the suction heads and photoelectrically reading out the surface patterns of a plurality of specified lines in the specified area on the surface of the bill, a memory for storing reference surface patterns of bills, and a comparator for receiving the reference surface patterns from the memory and the surface pattern from the photoreceptor and comparing the surface pattern received from the photoreceptor with the reference surface patterns. The memory stores, for each bill, four reference patterns, representing obverse and reverse sides of the bills in each of two orientations. Once the first bill in a stack has been recognised the patterns of subsequent bills may be compared only with the four reference patterns corresponding to the recognised bill.

F I G.1



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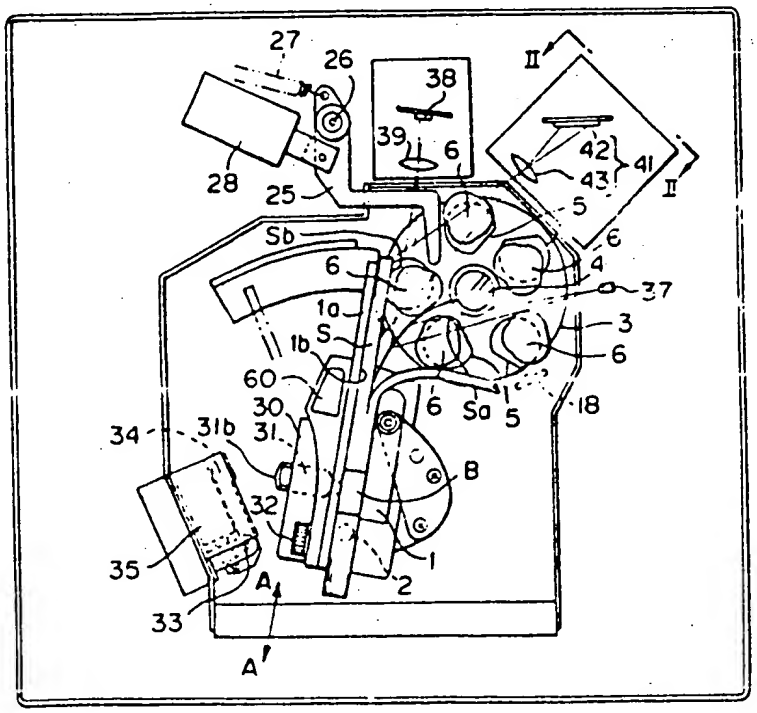
F I G.1



GB 2 204 166 A

1/14

FIG.1

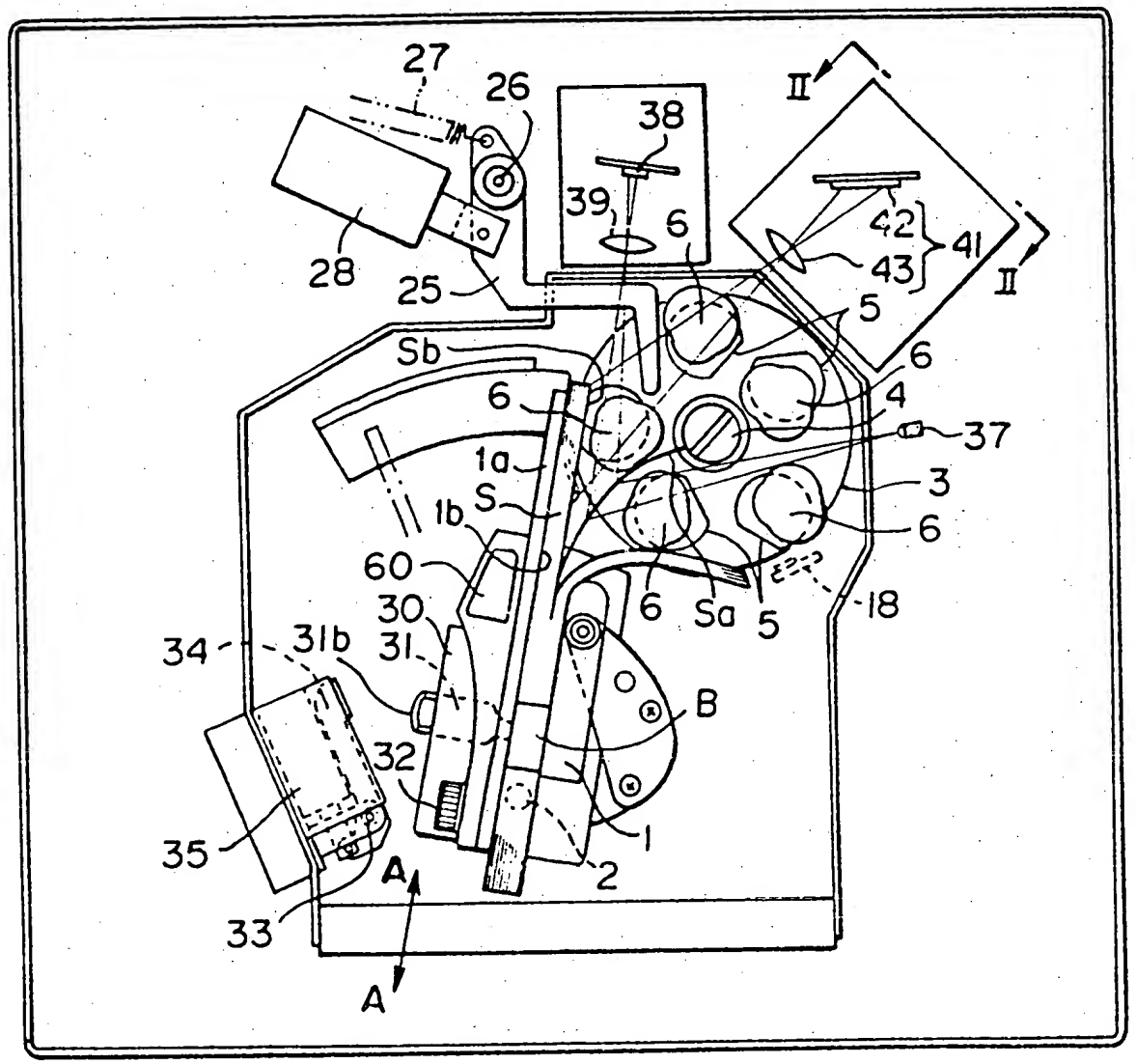
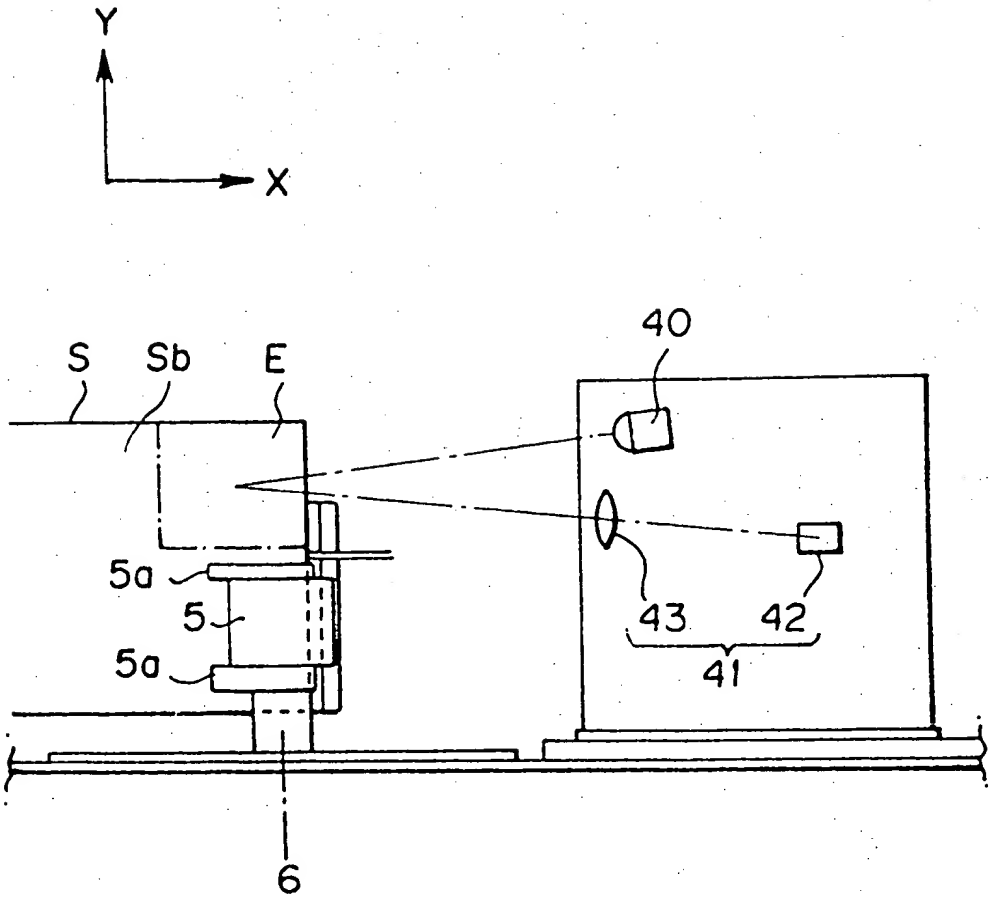

27
26
38
II
39
6
42
41
43
II
28
25
5
Sb
6
6
4
37
1a
3
S
1b
6
60
6
Sa
5
18
30
34
31b
31
B
32
35
1
2
A
33
A

FIG.2



3/14

FIG.3

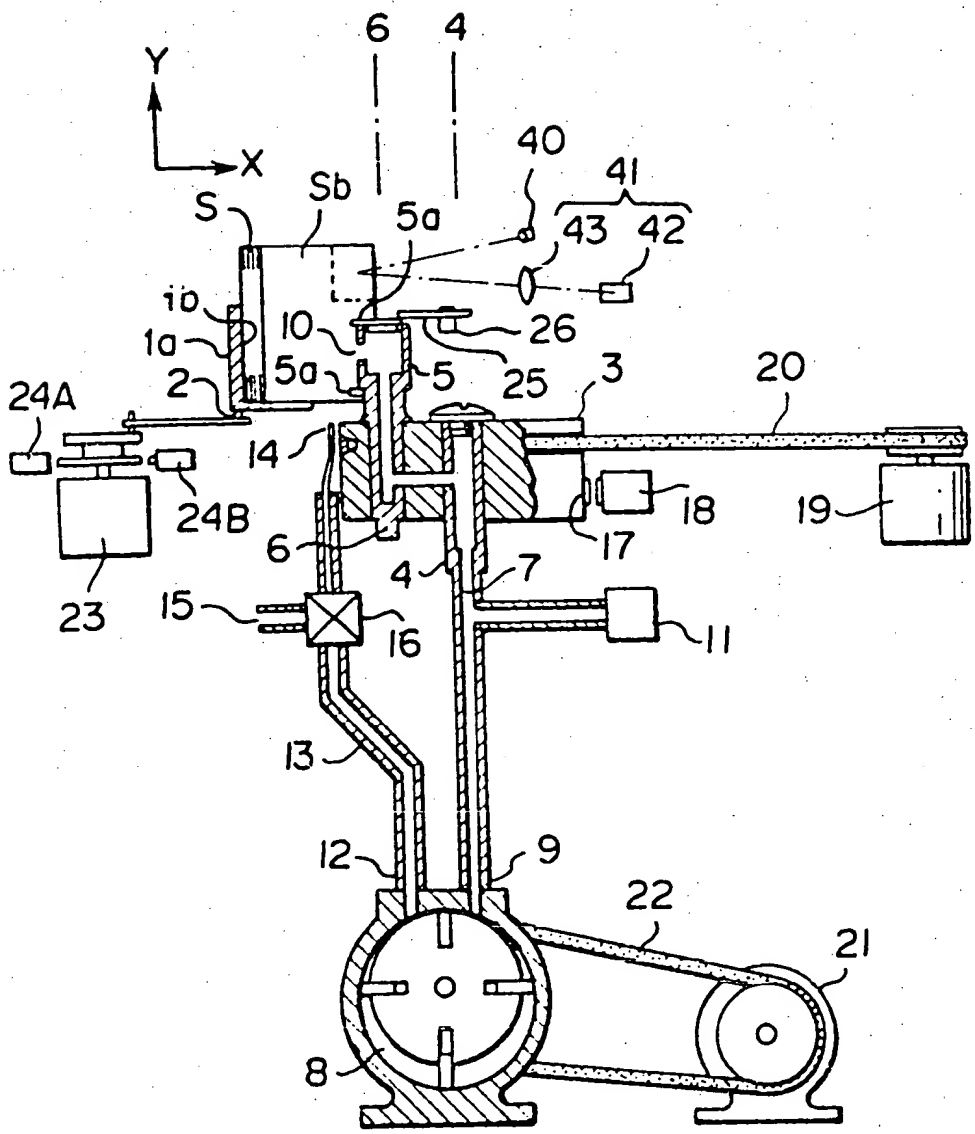
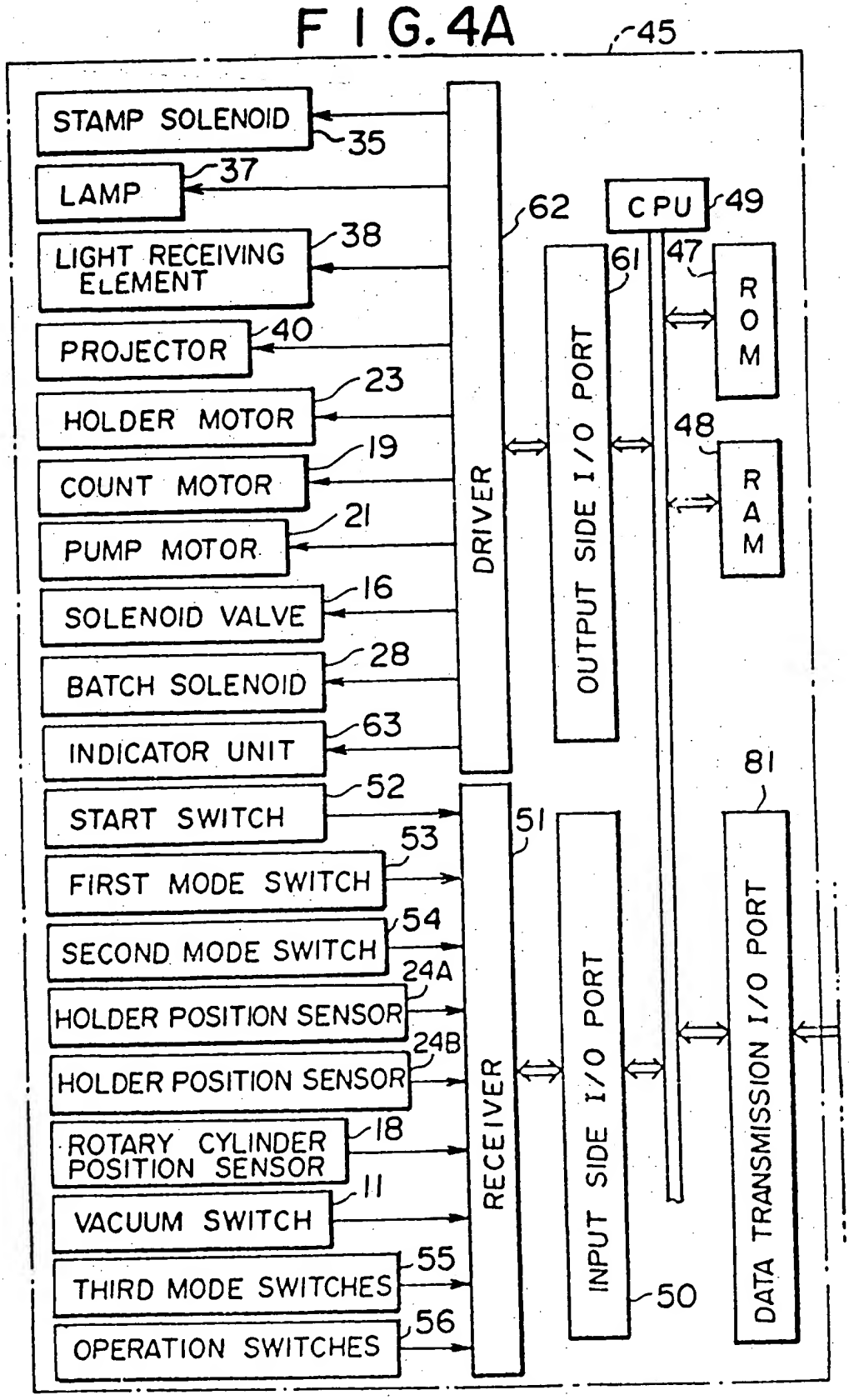

6
4
Y
X
40
41
S
Sb
5a
43
42
1b
1a
10
26
2
5a
5
25
3
20
24A
14
18
19
24B
17
6
4
7
23
15
16
11
13
12
9
22
21
8

FIG. 4A


45
STAMP SOLENOID
35
LAMP
37
LIGHT RECEIVING ELEMENT
38
PROJECTOR
40
HOLDER MOTOR
23
COUNT MOTOR
19
PUMP MOTOR
21
SOLENOID VALVE
16
BATCH SOLENOID
28
INDICATOR UNIT
63
START SWITCH
52
FIRST MODE SWITCH
53
SECOND MODE SWITCH
54
HOLDER POSITION SENSOR
24A
HOLDER POSITION SENSOR
24B
ROTARY CYLINDER POSITION SENSOR
18
VACUUM SWITCH
11
THIRD MODE SWITCHES
55
OPERATION SWITCHES
56
DRIVER
62
RECEIVER
51
OUTPUT SIDE I/O PORT
61
INPUT SIDE I/O PORT
50
CPU
49
47
ROM
48
RAM
81
DATA TRANSMISSION I/O PORT

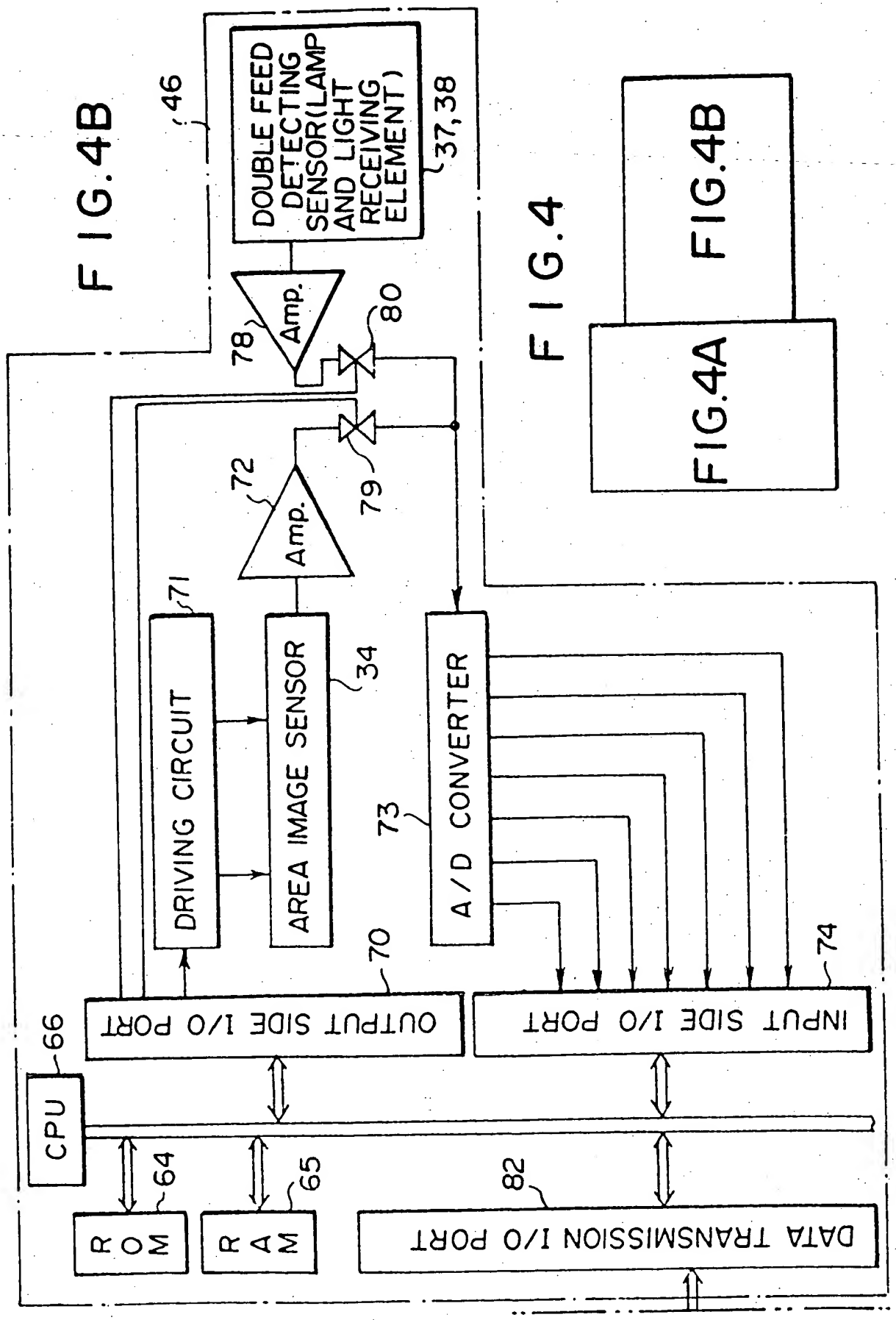
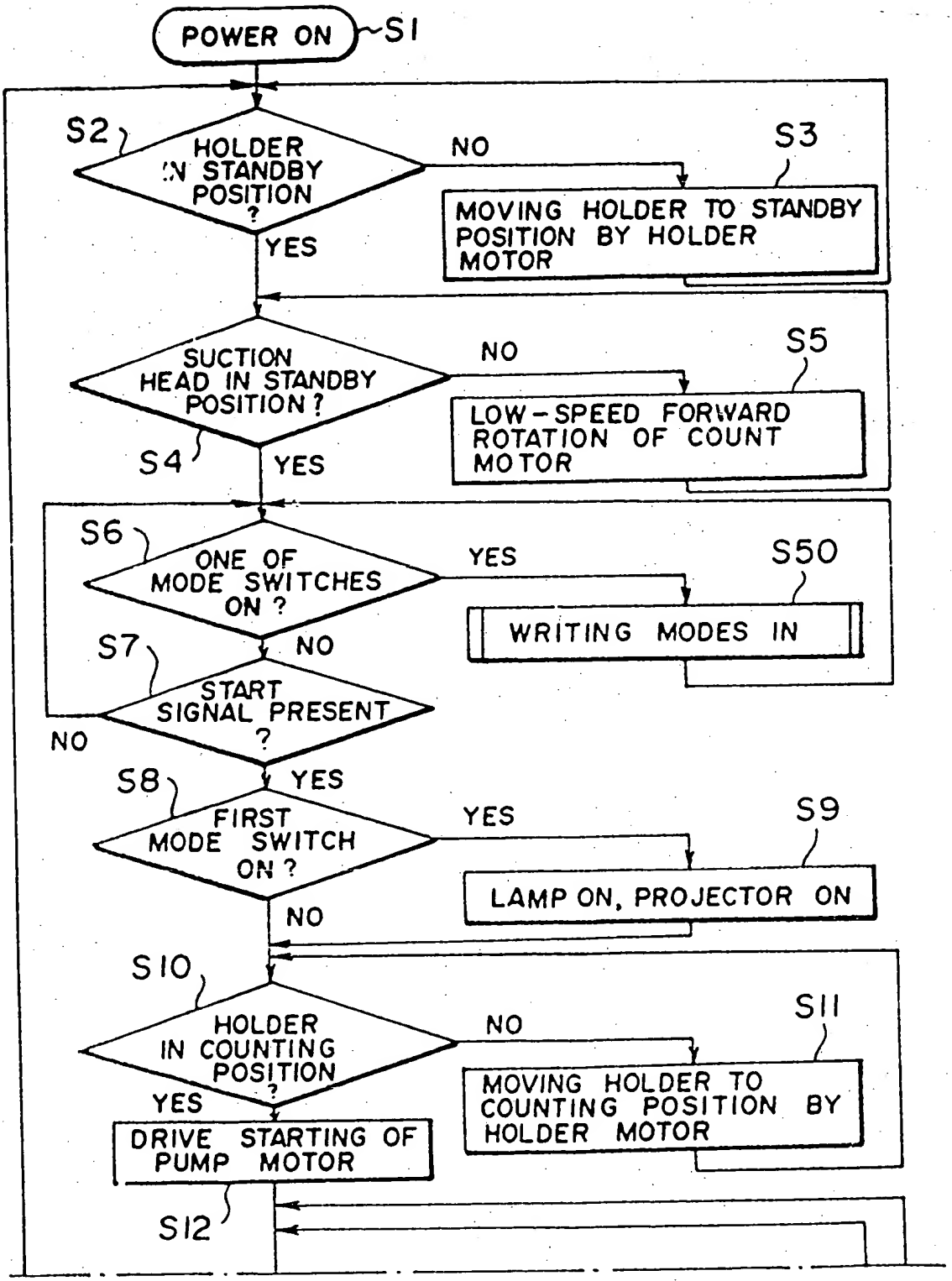


FIG.4
FIG.4A
FIG.4B
FIG.4B
DOUBLE FEED DETECTING SENSOR(LAMP AND LIGHT RECEIVING ELEMENT)
37,38
46
Amp.
78
80
79
72
Amp.
71
DRIVING CIRCUIT
AREA IMAGE SENSOR
34
A/D CONVERTER
73
70
74
OUTPUT SIDE I/O PORT
INPUT SIDE I/O PORT
66
CPU
64
65
82
ROM
RAM
DATA TRANSMISSION I/O PORT

FIG.5A


POWER ON
S1
S2
HOLDER IN STANDBY POSITION ?
NO
S3
MOVING HOLDER TO STANDBY POSITION BY HOLDER MOTOR
YES
SUCTION HEAD IN STANDBY POSITION ?
NO
S5
LOW-SPEED FORWARD ROTATION OF COUNT MOTOR
S4
YES
S6
ONE OF MODE SWITCHES ON ?
YES
S50
WRITING MODES IN
S7
NO
START SIGNAL PRESENT ?
NO
YES
S8
FIRST MODE SWITCH ON ?
YES
S9
LAMP ON, PROJECTOR ON
NO
S10
HOLDER IN COUNTING POSITION ?
NO
S11
MOVING HOLDER TO COUNTING POSITION BY HOLDER MOTOR
YES
DRIVE STARTING OF PUMP MOTOR
S12

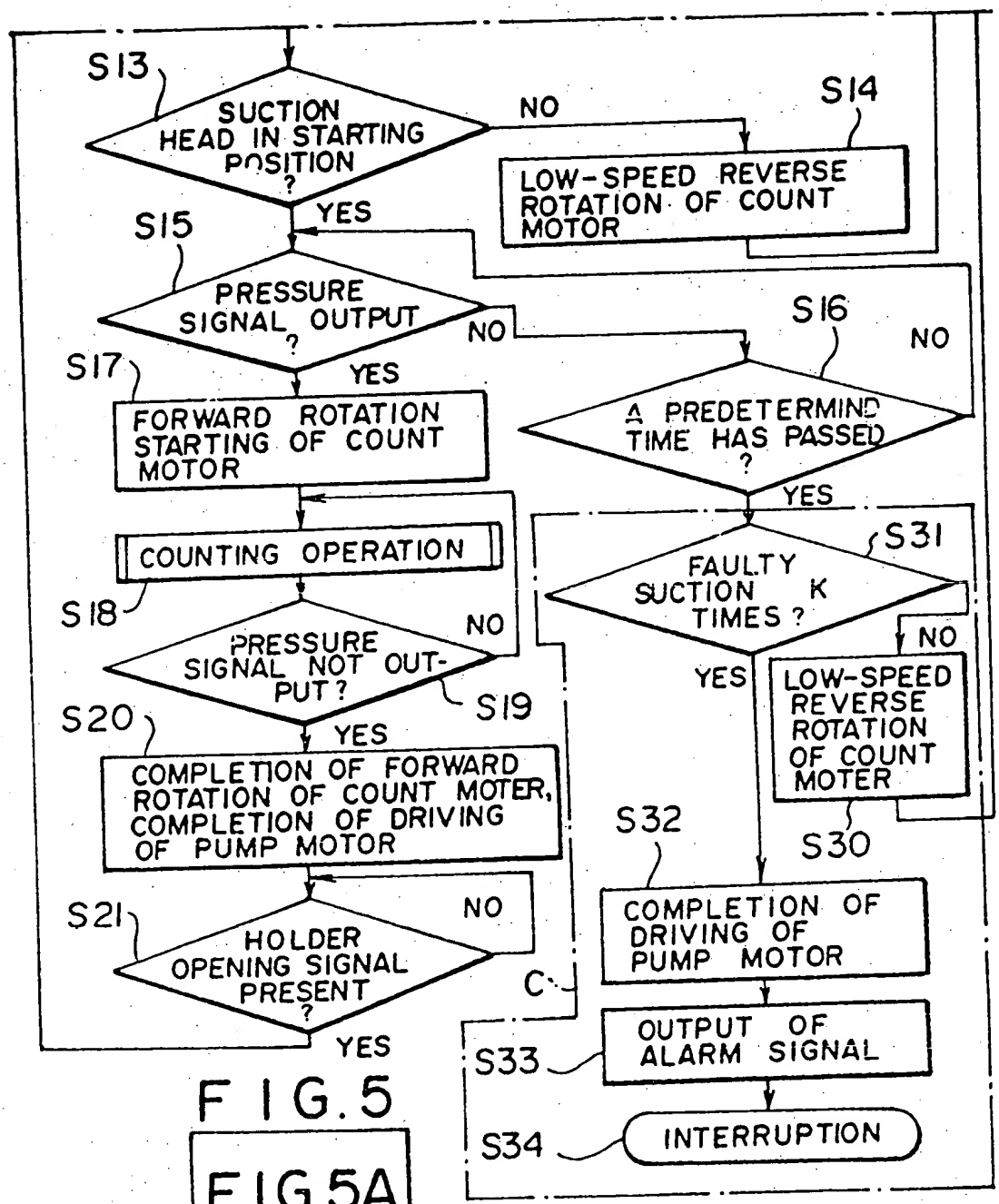


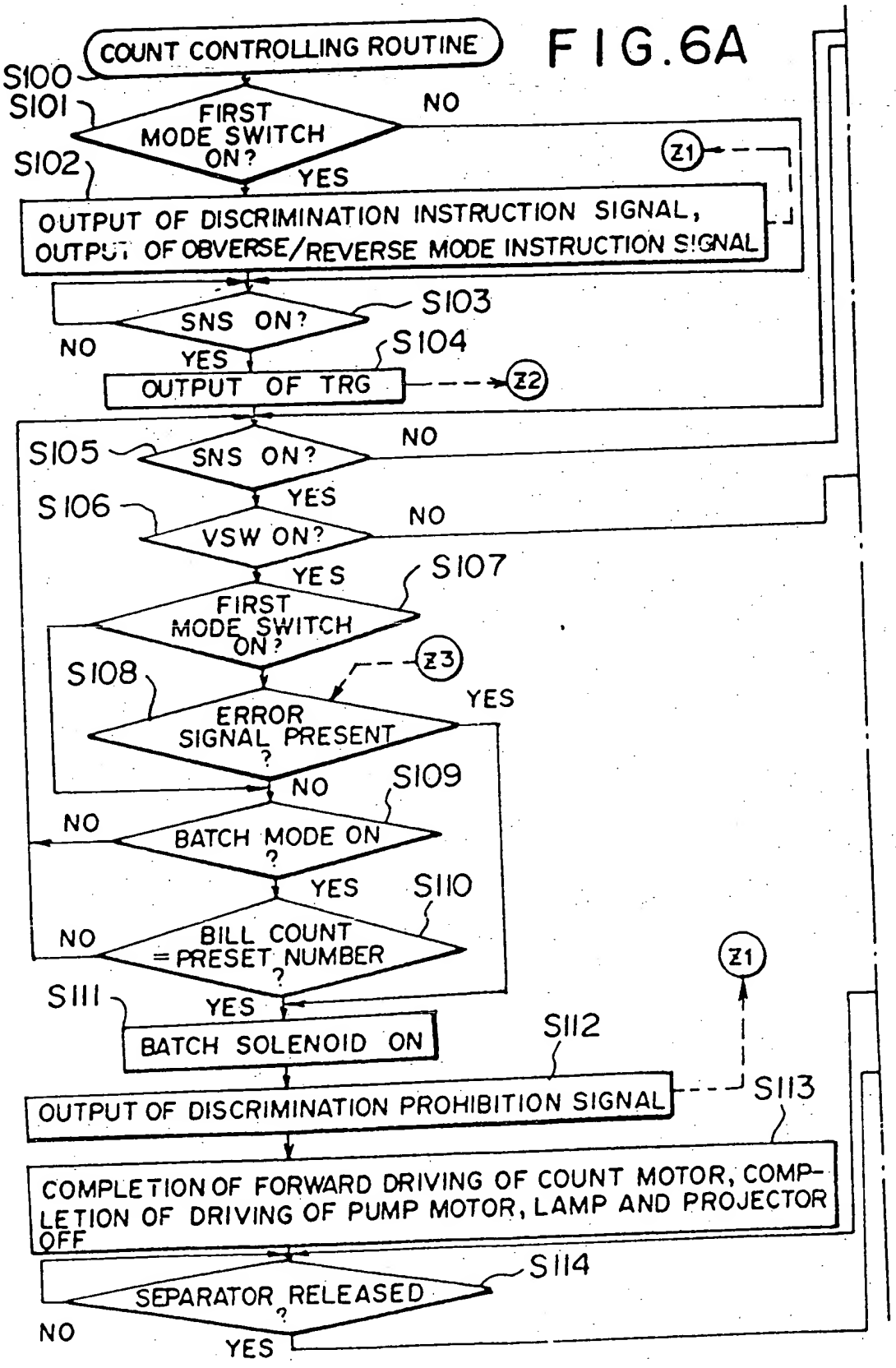
FIG.5

FIG.5A

FIG.5B

FIG.5B

FIG.6A


COUNT CONTROLLING ROUTINE
S100
S101
FIRST MODE SWITCH ON?
NO
YES
Z1
S102
OUTPUT OF DISCRIMINATION INSTRUCTION SIGNAL, OUTPUT OF OBVERSE/REVERSE MODE INSTRUCTION SIGNAL
SNS ON?
S103
NO
YES
S104
OUTPUT OF TRG
Z2
S105
SNS ON?
NO
YES
S106
VSW ON?
NO
YES
S107
FIRST MODE SWITCH ON?
Z3
S108
ERROR SIGNAL PRESENT?
YES
NO
S109
NO
BATCH MODE ON?
YES
S110
NO
BILL COUNT = PRESET NUMBER?
Z1
S111
YES
BATCH SOLENOID ON
S112
OUTPUT OF DISCRIMINATION PROHIBITION SIGNAL
S113
COMPLETION OF FORWARD DRIVING OF COUNT MOTOR, COMPLETION OF DRIVING OF PUMP MOTOR, LAMP AND PROJECTOR OFF
S114
SEPARATOR RELEASED?
NO
YES

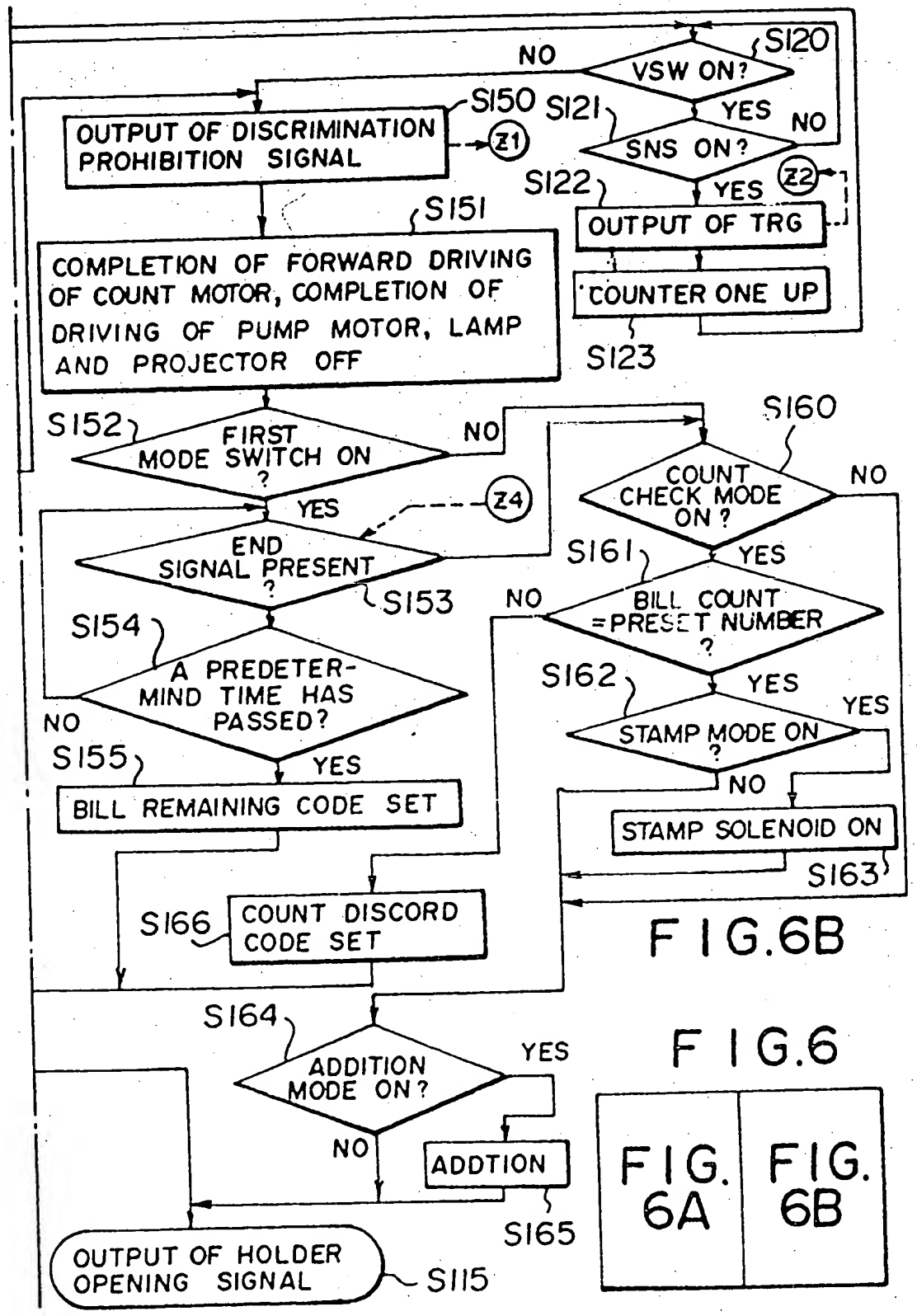
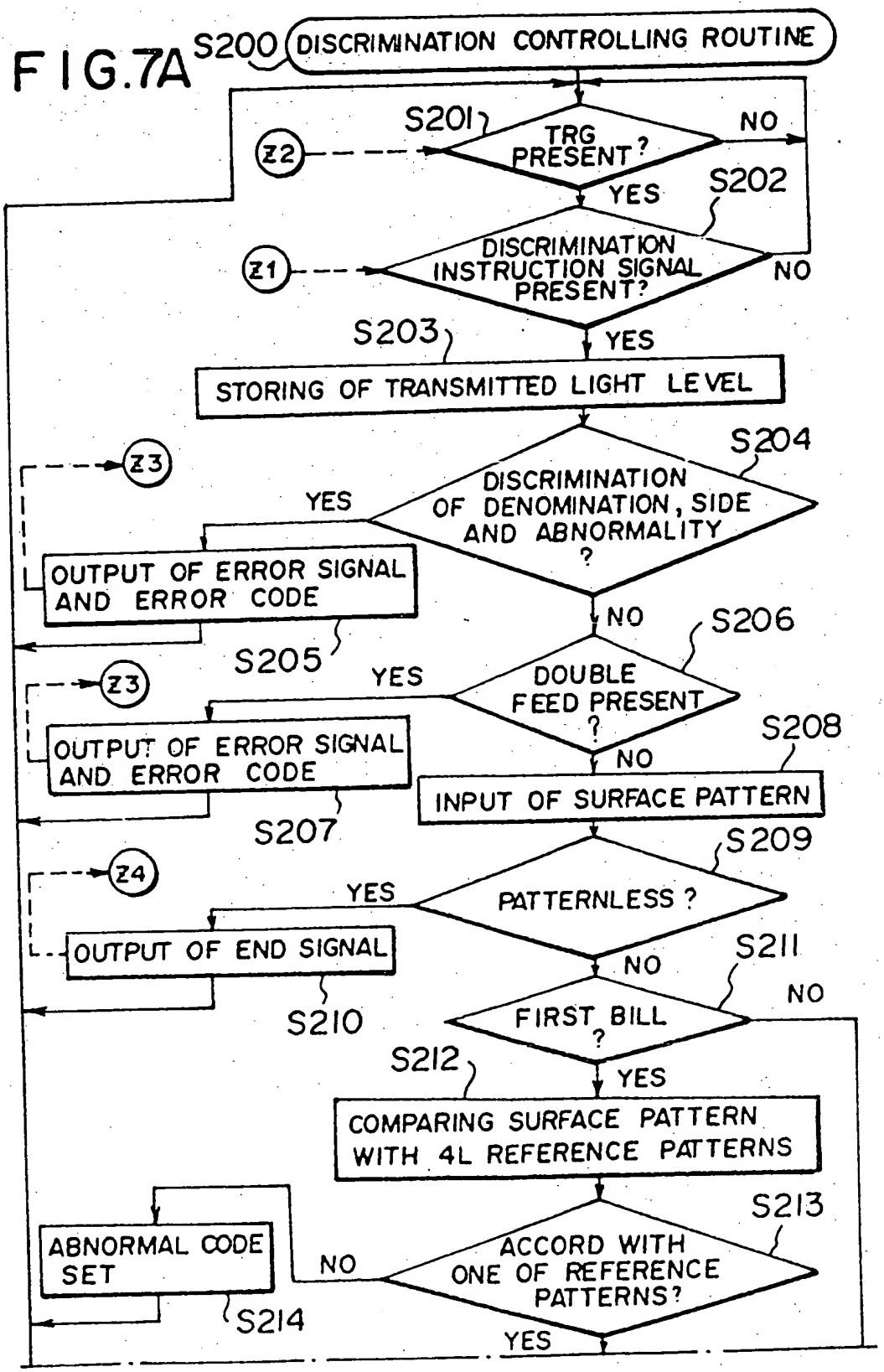


FIG.6B

FIG.6

FIG. 6A | FIG. 6B

FIG.7A


S200
DISCRIMINATION CONTROLLING ROUTINE
S201
TRG PRESENT?
NO
YES
Z2
S202
DISCRIMINATION INSTRUCTION SIGNAL PRESENT?
Z1
NO
YES
S203
STORING OF TRANSMITTED LIGHT LEVEL
S204
DISCRIMINATION OF DENOMINATION, SIDE AND ABNORMALITY ?
Z3
YES
OUTPUT OF ERROR SIGNAL AND ERROR CODE
S205
NO
S206
DOUBLE FEED PRESENT ?
Z3
YES
OUTPUT OF ERROR SIGNAL AND ERROR CODE
S207
NO
S208
INPUT OF SURFACE PATTERN
S209
PATTERNLESS ?
Z4
YES
OUTPUT OF END SIGNAL
S210
NO
S211
FIRST BILL ?
NO
YES
S212
COMPARING SURFACE PATTERN WITH 4L REFERENCE PATTERNS
S213
ACCORD WITH ONE OF REFERENCE PATTERNS?
NO
ABNORMAL CODE SET
S214
YES

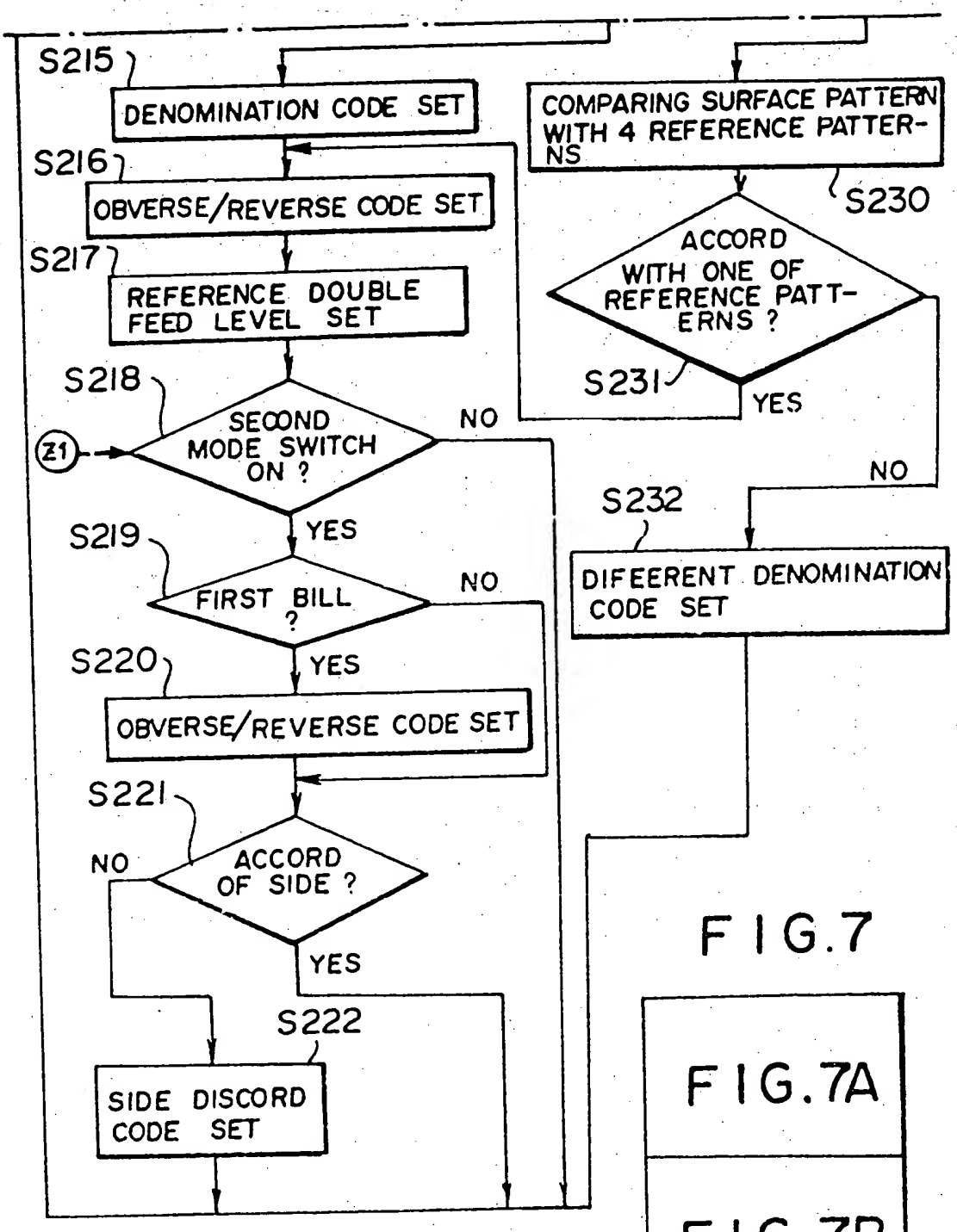


FIG.7B

FIG.7

FIG.7A

FIG.7B

FIG.8

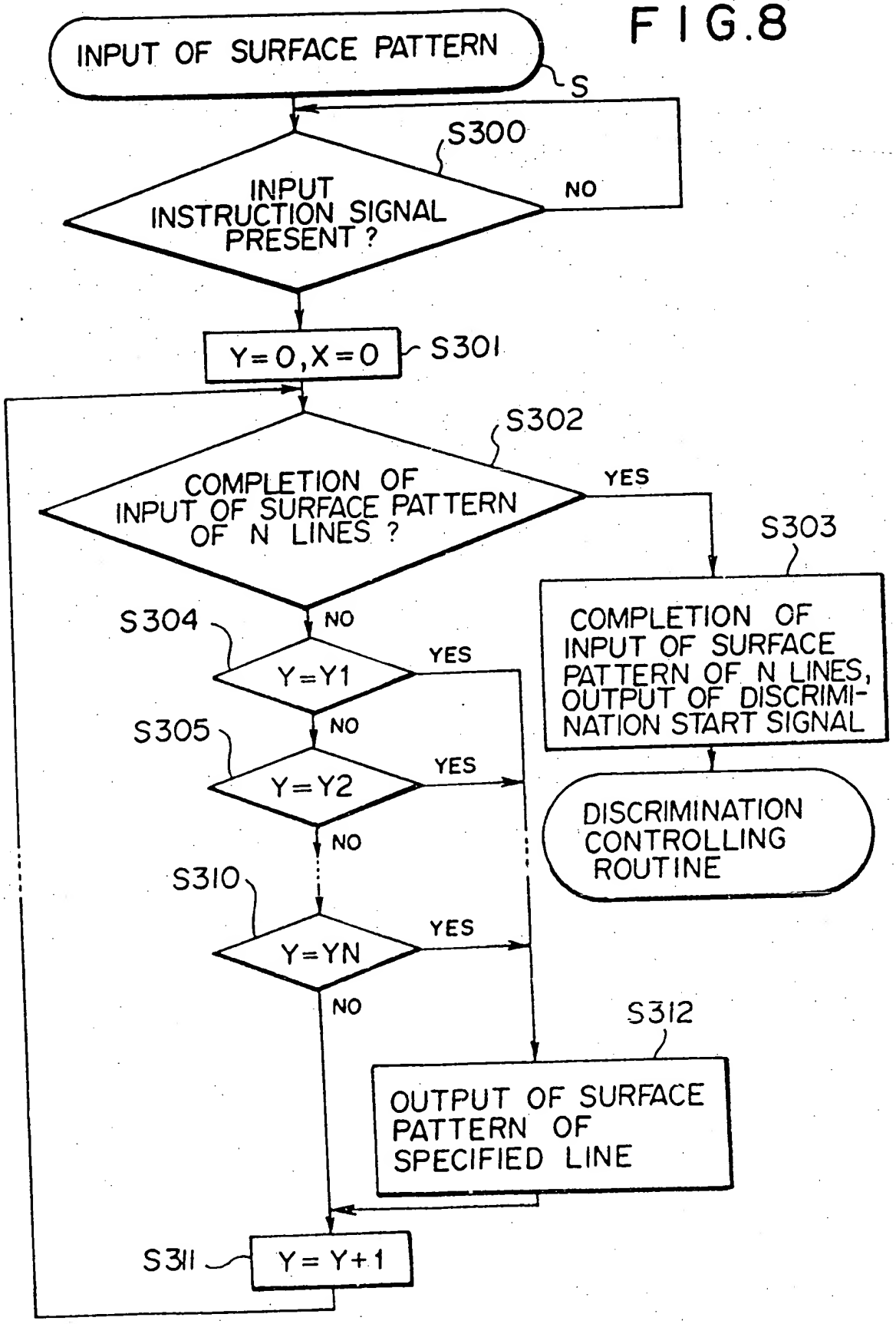

INPUT OF SURFACE PATTERN
S
S300
INPUT INSTRUCTION SIGNAL PRESENT ?
NO
Y=0,X=0
S301
S302
COMPLETION OF INPUT OF SURFACE PATTERN OF N LINES ?
YES
S303
COMPLETION OF INPUT OF SURFACE PATTERN OF N LINES, OUTPUT OF DISCRIMINATION START SIGNAL
DISCRIMINATION CONTROLLING ROUTINE
NO
S304
Y=Y1
YES
NO
S305
Y=Y2
YES
NO
S310
Y=YN
YES
NO
S312
OUTPUT OF SURFACE PATTERN OF SPECIFIED LINE
S311
Y=Y+1

FIG.9

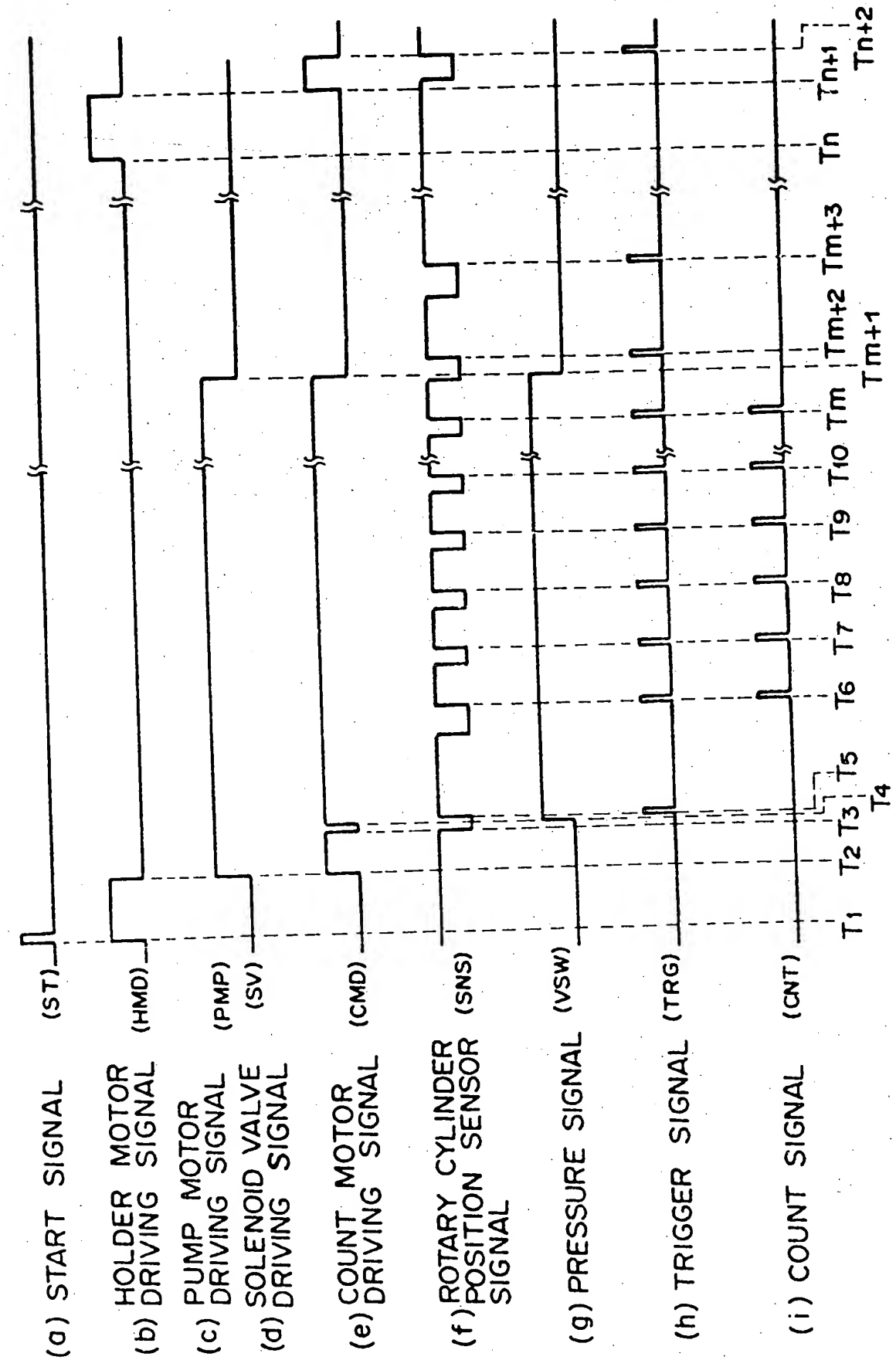
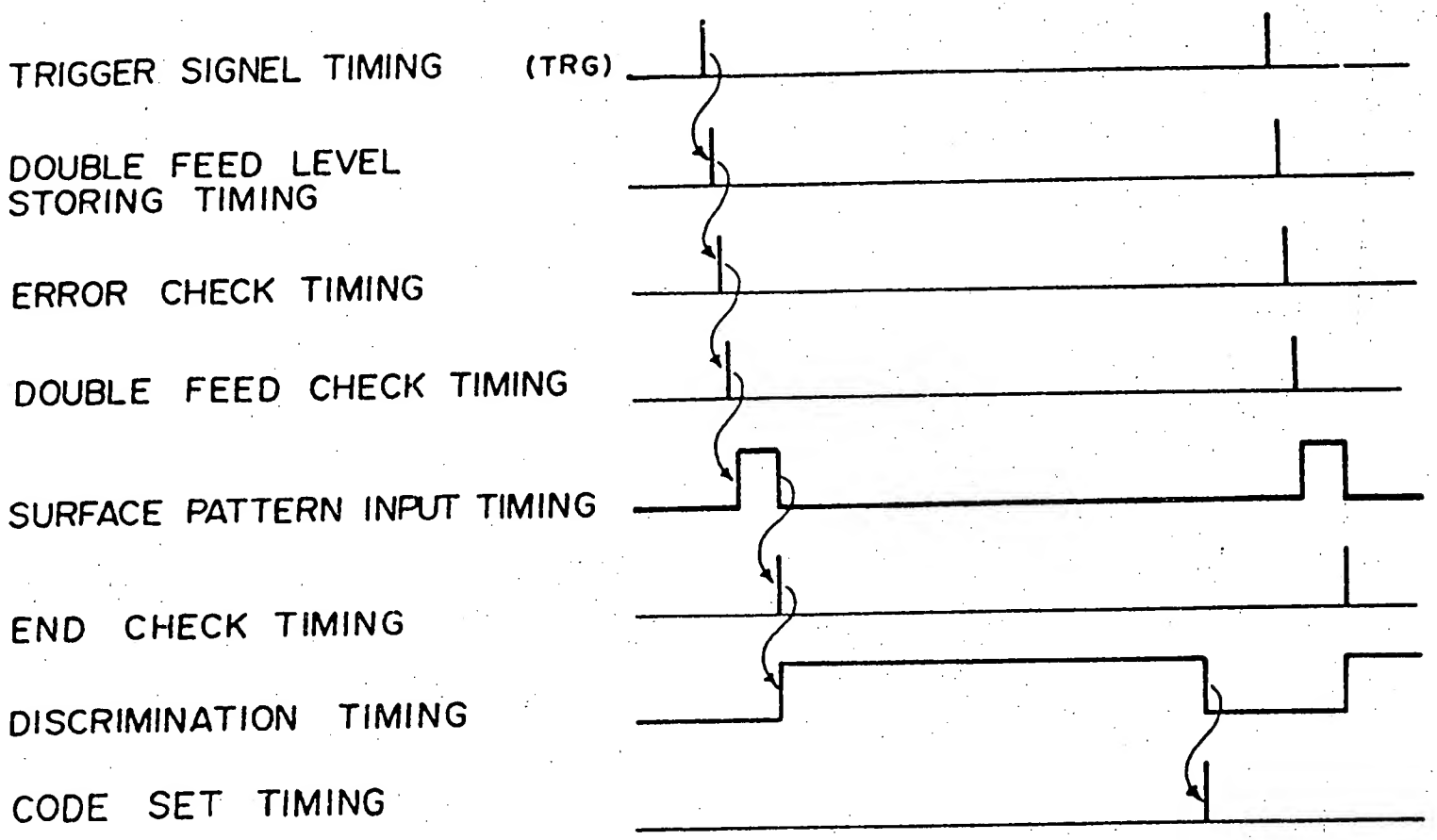

(a) START SIGNAL
(ST)
(b) HOLDER MOTOR DRIVING SIGNAL
(HMD)
(c) PUMP MOTOR DRIVING SIGNAL
(PMP)
(d) SOLENOID VALVE DRIVING SIGNAL
(SV)
(e) COUNT MOTOR DRIVING SIGNAL
(CMD)
(f) ROTARY CYLINDER POSITION SENSOR SIGNAL
(SNS)
(g) PRESSURE SIGNAL
(VSW)
(h) TRIGGER SIGNAL
(TRG)
(i) COUNT SIGNAL
(CNT)
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 Tm Tm+1 Tm+2 Tm+3 Tn Tn+1 Tn+2

FIG.10



2204166

DISCRIMINATING APPARATUS FOR BILL COUNTING MACHINE

The present invention relates to a discriminating apparatus for a bill counting machine and, particularly, to such an apparatus capable of discriminating whether or not bills or bank notes are being fed one by one, as well as the kind of bills.

The general functions of a bill counting machine are that of counting the number of bills by sucking and turning over bills one by one by means of the negative pressure of suction heads that rotate while revolving and that of checking for presence of bills whose denominations are different from that of the bills being counted.

U.S. Patent No. 4,677,682 proposes a bill

counting machine having the above described functions. In a discriminating apparatus of this bill counting machine, whether the bill is placed with its obverse side directed upwardly or downwardly as well as the kind of bill is discriminated by directing a light onto a rectilinear portion on the surface of the bill and photoelectrically detecting the light reflected by the bill to read out the surface pattern of the bill rectilinearly and comparing the read-out surface pattern with a stored reference surface standard pattern.

However, in this prior art bill discriminating apparatus, since the surface pattern of the bill is read out by directing the light onto a predetermined rectilinear portion of the surface of the bill and photoelectrically detecting the reflected light from the rectilinear portion, in case where the kind of bill to be discriminated is changed, for example, it is changed from Japanese yen bills to U.S. dollar bills or another new kind of bill, the position of the rectilinear portion has to be changed by adjusting the positions and/or directions of a light emitting device and a light receiving device and the apparatus design has to be often changed. Further, in the prior art apparatus, since the kind of bill has to be discriminated by reading out the surface pattern of only one rectilinear portion, it is impossible to determine the position of the irradiated portion so that an optimum surface pattern of the bills can be obtained for all kinds of bills, which makes it difficult to discriminate the kind of the bill with high accuracy.

An object of the present invention to provide a discriminating apparatus for a bill counting machine capable of discriminating various kinds of bills without changing the positions and/or directions of a photo-emmitter and a photoreceptor and the design of the discriminating apparatus.

According to the present invention, a discriminating apparatus for a bill counting machine comprises holder means for holding a stack of bills and suction head means for sucking the bills from the holder means and turning over the bills one by one, light projecting means for emitting a ray of light onto the specified area on the surface of the bill tob e discriminated, read out menas for receiving light reflected by the bill while the bill is turned over by the suction head means and reading out the surface pattern of a plurality of specified lines in the specified area of the bill, storing means for storing reference surface patterns of bills, and comparing means for reading out the reference surface patterns from the sorting means and the surface pattern the the read out means and comparing the surface pattern read out from the read out means with the reference surface patterns.

Preferably, for each of L denominations of bills to be discriminated, the storing means stores a right-side-up pattern and an up-side-down pattern for both the obverse and reverse sides of the bill, the

total number of the reference surface patterns stored thus being 4L.

Preferably, the apparatus further includes reference patterns selecting means for selecting reference surface patterns from among the reference surface patterns stored in the storing means in accordance with whether the bill to be discriminated is the first identified bill or not, all 4L reference surface patterns being selected for discrimination of bills up to and including the first identified bill and only the four reference surface patterns of the first identified bill being selected for the discrimination of the other bills, the comparing means being adapted to read out the selected reference surface patterns from the reference pattern selecting means and the surface pattern from the read out means for comparing the surface pattern read out from the read out means with the selected reference surface patterns.

In the present application, the first identified bill is defined as the first bill whose surface pattern matches one of the reference surface patterns stored in the storing means.

In the accompanying drawings:

Figure 1 is a schematic drawing showing a plan view of a bill counting machine provided with a bill discriminating apparatus;

Figure 2 is a schematic drawing showing an end view taken along a line A-A of Figure 1;

Figure 3 is a schematic drawing showing a cross-sectional view of suction heads and a suction pipeline which is employed in the bill discriminating apparatus shown in Figure 1;

Figure 4 is a block diagram showing a count controlling circuit and a discrimination controlling circuit employed in the bill discriminating apparatus shown in Figure 1;

Figure 5 is a flow chart showing an example of the counting operation in the bill discriminating apparatus shown in Figure 1;

Figure 6 is a flow chart showing an example of the operation of a CPU in a count controlling circuit in the bill discriminating apparatus shown in Figure 1;

Figures 7 and 8 are flow charts showing an

example of the operation of a CPU in a discrimination controlling circuit in the bill discriminating apparatus shown in Figure 1;

Figure 9 is a time chart showing wave forms of signals employed in the bill discriminating apparatus shown in Figure 1; and

Figure 10 is a timing chart showing the timing of operations in the bill discriminating apparatus shown in Figure 1.

Referring to Figures 1 to 3, the arrangement of the mechanism of a bill counting machine will be described. Bills S are loaded in a holder 1 and moved to the counting

position indicated by solid lines in Figure 1 or to a stand-by position indicated by phantom lines in Figure 1 as the holder 1 is horizontally rotated about a shaft 2. When the holder 1 is in the counting position, the suction heads 5 on a rotary cylinder 3 are rotated clockwise about shafts 6 while the rotary cylinder 3 is rotated counterclockwise about a shaft 4 as viewed in Figure 1. Counting is effected by causing negative pressure to act on the inside of the suction heads 5 so as to turn over the bill S on the holder 1 one by one.

At the same time, the discrimination of bill denominations can be effected as light is projected onto a portion including a plurality of lines on the surface of the bills S from a projector or a light emitting device and the light reflected by the bills S is read out by means of a receptor or light receiving device, which will be described later.

The holder 1 is provided with a base plate 1a for supporting the bills S from the rear side (the opposite side from the suction head 5) and the surface 1b of the base plate 1a is blackened in order to decrease the reflectance thereof.

As shown in Figure 3, the respective shafts 4 and 6 of the rotary cylinder 3 and the suction heads 5 are formed in a hollow shape and are connected to the suction port 9 of a vacuum pump 8 via a suction pipeline 7. The bills S are sucked by the suction heads 5, as the vacuum pressure of the

vacuum pump 8 acts on the bills S via an opening 10 provided at a peripheral portion of the suction heads 5. In addition, a vacuum switch 11 is provided midway of the suction pipeline 7. The vacuum switch 11 indicates that the negative pressure inside the suction pipeline 7 has risen to an extent that the bills S are sufficiently sucked.

Meanwhile, an exhaust pipeline 13 is connected to the exhaust port 12 of the vacuum pump 8. An exhaust nozzle 14 for facilitating the separating of bills S by blowing exhaust air onto one side of bills S is provided at the end of this exhaust pipeline 13. On the other hand, midway of the exhaust pipeline 13 is provided a solenoid valve 16 for preventing the occurrence of noise from the exhaust nozzle 14 when bills S are not being counted by changing over the exhaust air to a discharge port 15.

Further, as shown in Figures 1 to 3, a pair of position regulating pieces 5a are fixed to each head 5. The position regulating pieces 5a of each pair are formed so as to be respectively projected from the side surface of the suction head 5 with the opening positioned therebetween. These pieces 5a prevent the bills S attracted by the suction head 5 from falling down and being folded as the vacuum pressure acts on the bills S via the opening 10. Thus, the bill S sucked by the suction head 5 is positioned at a portion (designated as Sa in Figure 1) where it is detected whether the bills S are being fed one by one while it is being held in standing orientation by the position regulating pieces 5a.

Furthermore, a plurality of actuating pieces 17 each constituted by a magnetic body are attached to the periphery of the rotary cylinder 3. Whether a suction head 5 is in its standby position (the position in which the opening 10 faces the bills S and the bore of the suction head 5 communicates with the vacuum pump 8) or in the starting position (the position in which the opening 10 is about to face the bills S and in which the bore of the suction head 5 is shut off from the vacuum pump) is detected according to whether or not a magnetic sensor 18 is actuated by the respective actuating pieces 17 or not.

In Figure 3, the reference numeral 19 denotes a count motor for driving the rotary cylinder 3 via a belt 20; the reference numeral 21 denotes a pump motor for driving the vacuum pump 8 via a belt 22; the reference numeral 23 denotes a holder motor for rotating the holder 1; and the reference numerals 24A and 24B denote holder position sensors for detecting whether the holder 1 is in its counting position (where the holder 1 is near the suction head 5) or in its standby position (where the holder 1 is away from the suction head 5).

Furthermore, a separator 25 is provided in the vicinity of the rotary cylinder 3. The separator 25 is supported horizontally rotatably by a shaft 26 and is urged counterclockwise as viewed in Figure 1 by means of a spring 27. Further, the separator 25 is adapted to rotate clockwise as viewed in Figure 1 by the operation of a batch solenoid 28.

This separator 25 has the function of separating a bill which has been turned over and a bill which has not yet been turned over as it is inserted between said bills, when a bill of a different denomination is detected, as will be explained later.

Next, a mechanism for impressing a confirmation stamp on the wrapper B of the bundle of bills will be described.

In Figure 1, the reference numeral 30 denotes a stamp holding member provided for the holder 1 and a stamp 31 is supported so as to be movable in the direction A-A and movable between a position close to the bills S and a position away from the bills S by the stamp holding member 30. A dial 32 is provided at a base portion of the holder 1 and as the dial 32 is turned, the stamp 31 is moved in the direction A-A, thereby to be positioned so as to face the wrapper B.

Further, there are provided on a base table for supporting the holder 1 a drive arm 34 swingable about a shaft 33 in the horizontal plane and a solenoid 35 for swinging the drive arm 34. As the drive arm 34 is swung by the solenoid 35 to press the rear end 31b of the stamp 31 toward the wrapper B, the front end 31a of the stamp 31 approaches the wrapper B, whereby the wrapper B is stamped.

Referring to Figure 1, the mechanism for discriminating whether bills S are being turned over one by one, that is, for detecting double feed of bills S, will be described hereinbelow.

In Figure 1, the reference numerals 37 and 38 respec-

tively denote a lamp for emitting light and a light receiving element which together constitute a double feed detecting sensor, and the reference numeral 39 denotes a condenser lens for condensing the light emitted from the lamp 37 to the light receiving element 38.

The lamp 37 and the light receiving element 38 are arranged so as to face the rotary cylinder 3 and, as a result, each bill Sa turned over by the suction head 5 is exposed to the light emitted from the lamp 37 at substantially the central portion thereof in such a manner that the light intersects the surface of the bill Sa obliquely.

The light receiving element 38 photoelectrically detects the light transmitted through the bill Sa and the double feed of bills S is discriminated based upon the amount of the transmitted light detected thereby. More specifically, if the amount of the transmitted light is more than a predetermined amount, it is discriminated that only one bill Sa is being fed. On the contrary, if the amount of the transmitted light is not more than the predetermined amount, double feed of bills is discriminated.

Further, a mechanism for discriminating between different denominations of bills and the obverse and reverse sides of bills will be described hereinbelow.

Referring to Figures 1 to 3, the reference numeral 40 denotes a projector for projecting the uppermost bill Sb of the stacked bills S and the reference numeral 41 denotes a light receptor (light detecting element) for receiving the

light projected onto and reflected by the uppermost bill Sb. The relationship between the projector 40 and the stacked bills S is determined so that the area of the uppermost bill Sb containing an area E indicated by a phantom line in Figures 2 and 3 is exposed to the light emitted from the projector 40.

The light receptor 41 is constituted by an area image sensor 42 for producing electrical signals in response to the surface pattern of the bill Sb and a condenser lens 43 for causing the reflected light to converge onto the area image sensor 41. The area image sensor 41 is formed by a plurality of line image sensors arranged two-dimensionally and is operated by a trigger signal TRG issued from a discrimination controlling circuit 46 which will be described in detail later so as to scan the area E on a point-by-point basis to convert the amount of the light reflected by individual pixels of the specified portion in the area E into electrical signals, thereby to output signals having a wave form corresponding to the surface pattern of the specified portion in the area E of the bill Sb. More specifically, since the coordinates of the area image sensor 41 correspond to the coordinates of the area E, if the X coordinates (abscissa) and Y coordinates (ordinate) of the area image sensor 41 are specified, the individual pixels in the area E, the X and Y coordinates of which correspond to those of the area image sensor 34, can be read out. So, if the Y coordinate is fixed and the X coordinate is changed from 0 to the final coordinate in increments of one, the surface

pattern of a specific line in the area E can be read out. Then, if similar operations are effected for one or more different Y coordinates corresponding to those within the area E, the surface patterns of a plurality of lines in the area E can be read out. The thus-obtained surface pattern of the lines in the area E is compared with reference surface patterns stored in a ROM 64 which will be described later and the denomination of the bill Sb and the side of the bill Sb are discriminated as described in detail later. The Y coordinates to be specified are experimentally determined in advance so that all denominations of bills can be discriminated from each other.

Next, description will be made with reference to Figure 4 of a count controlling circuit 45 for operating the counting mechanism and a discrimination controlling circuit 46 for operating the discriminating mechanism, respectively.

Briefly, the count controlling circuit 45 comprises a ROM 47 for storing a count controlling program (refer to Figures 5 and 6) which will be described later, a RAM 48 for writing and reading various data according to the program stored in the ROM 47 and a CPU 49 for controlling the ROM 47 and RAM 48. Further, the following are connected to the CPU 49 via an input side I/O port 50 and a receiver 51: a start switch 52 for issuing a command to start the counting operation; a first mode switch 53 for selecting a bill denomination and double feed mode in which only discrimination of the denomination and the double feed of the bills are to be

carried out at the time of counting; a second mode switch 54 for selecting an obverse/reverse mode in which discrimination of the obverse or reverse side of the bills is to be carried out in addition to the discrimination of the denomination and the double feed of the bills; holder position detecting sensors 24A and 24B for detecting whether the holder 1 is in its counting or standby position; rotary cylinder position sensor 18; a vacuum pressure sensor 11; a plurality of mode switches 55, such as a switch for selecting a count check mode in which it is judged whether or not the count of bills accords with the number of bills preset, a switch for selecting a stamp mode in which the count check mode is turned on and the stamping operation is effected only when the count of bills accords with the number of bills preset, a switch for selecting a count mode which is automatically selected when the count check mode is off and in which the holder 1 is moved to the standby position after the counting is completed, a switch for selecting an addition mode in which the count check mode, the stamp mode and the count mode are on and a count for a bundle of bills is effected, a switch for selecting a batch mode in which the suction heads 5 are prevented from turning over the bills by the separator 25 at the time when the count of bills becomes equal to the preset number of bills; and a plurality of operation switches 56 such as a clear switch for clearing various modes.

In this embodiment, although the start switch 52 is constituted by a pushbutton 60 (refer to Figure 1) provided

on the holder 1, it is also possible, for instance, to use as a start switch 52 a sensor (not shown) for detecting that bills S have been loaded on the holder 1.

Additionally, to the CPU 49 are respectively connected via an output side I/O port 61 and a driver 62, the solenoid 35 for stamping, the lamp 37, the projector 40, the holder motor 23, the counting motor 19, the pump motor 21, the solenoid valve 16, batch solenoid 28, and an indicator unit 63 provided on an operating panel (not shown) of a bill counting machine or the like to display the number of bills, the presence of abnormalities, etc.

Meanwhile, the discrimination controlling circuit 46 comprises: a ROM 64 for storing the discrimination controlling program (refer to Figures 7 and 8), reference surface patterns, reference double feed levels and the like; a RAM 65 for writing in and reading out various data according to the program stored in the ROM 64; and a CPU 66 for controlling the ROM 64 and RAM 65. Additionally, the area image sensor 34 is connected to the CPU 66 via an output side I/O port 70 and a driving circuit 71. The output of the area image sensor 34 is input to the CPU 66 via an amplifier 72, an A/D converter 73 and an input side I/O port 74.

Further, the driving circuit 71 outputs X (abscissa) axis driving signals and Y (ordinate) axis driving signals to the area image sensor 34 and according to these X and Y axis driving signals, the area image sensor 34 reads out the surface pattern of the pixels specified by these driving

signals within the area E of the bill Sb. More specifically, the Y (ordinate) axis driving signal is first output from the driving circuit 71 to specify the Y coordinate of the area image sensor 34 corresponding to that of the pixel within the area E the surface pattern of which is to be read out and, then, the X (abscissa) axis driving signal is output to specify the X coordinate of the area image sensor 34 corresponding to that of the pixel within the area E the surface pattern of which is to be read out. Thus, the amount of the reflected light from the specified pixel within the area E can be read out. Then, similar operations are carried out by changing the X coordinate from 0 to the final coordinate in increments of one, while the Y coordinate is fixed, whereby the surface pattern of one line in the area E can be read out. Further, the surface pattern of another line in the area E can be read out similarly by changing the Y coordinates. By repeating the same operation for different Y coordinates, the surface pattern of a plurality of lines in the area E can be read out. The thus-obtained surface pattern of the lines in the area E is compared with the reference surface patterns stored in the ROM 64, whereby the discrimination of the bill S can be effected.

On the other hand, the double feed detecting sensor consisting of the lamp 37 and the light receiving element 38 is connected to the A/D converter 73 via an amplifier 78. Between the amplifiers 72 and 78 and the A/D converter 73, there are provided analog switches 79 and 80 operated by

switching signals output from the output side I/O port 70. Either the output signals from the area image sensor 34 or the double feed detecting sensors 37 and 38 are selectively fed to the A/D converter 73 by switching the analog switches 79 and 80.

Further, the CPU 49 of the count controlling circuit 45 and the CPU 66 of the discrimination controlling circuit 46 are connected to each other via the I/O ports 81 and 82 for data transmission so as to be capable of exchanging data, thereby effecting an interlinked operation.

The mode of operation of the above described discriminating apparatus is as follows.

In the case where the first mode switch 53 is turned on, the operation for discriminating the denomination of a bill and a double feed of bills are carried out in addition to the bill counting operation. However, since the second mode switch 54 can be turned on only when the first mode switch 53 is on, in the case where the second mode switch 54 is turned on, the operation for discriminating the side of the bill is effected in addition to the bill denomination discriminating operation, the double feed operation and the bill counting operation. On the other hand, in the case where the first mode switch 53 is off, the second mode switch 54 is also off and only the bill counting operation is effected.

In this embodiment, the bill denomination and double feed mode and the obverse/reverse mode are selected in

combination with other known modes, that is, the count mode, the addition mode, the count check mode, the stamp mode and the batch mode.

In the count mode, the number of bills stacked in the holder 1 is counted and displayed on the indicator unit 63.

In the addition mode, each time the counting operation is completed, the bill count for the operation is added to the sum of the bill counts and the new sum of the bill counts is displayed on the indicator unit 63.

In the count check mode, the bill count is compared with the number of bills preset by an operator and, in the case where they accord with each other, the holder 1 is moved to the standby position and, in the case where they do not accord with each other, the holder 1 is maintained at the counting portion until the clear switch is turned on.

In the stamp mode which is selected together with the count check mode, in the case where the bill count accords with the number of bills preset by an operator, the wrapper B is stamped and the holder 1 is moved to the standby position, and, in the case where they do not accord with each other, the stamping operation is not effected and the holder 1 is maintained at the counting portion until the clear switch is turned on.

In the batch mode, at the time when the bill count accords to the number of bills preset by an operator, the counting operation is stopped by the separator 25 and the preset number of bills is taken out from the counting machine.

Switches 55 are provided for selecting one or more modes described above but switches for selecting the individual modes are omitted in the accompanying drawings.

Description will be made of the operation mode of the discriminating apparatus which is an embodiment of the present invention described above in the case where the first mode switch 53 and the second mode switch 54 are on.

First, bills are stacked in the holder 1 at the standby position shown by a phantom line in Figure 1 and the pushbutton 60 is pushed, whereby the start switch 52 is turned on and the start signal is input to the count controlling circuit 45. Thus, the count operation is started.

After it is confirmed that the first and second mode switches 53 and 54 are on, the lamp 37 and the projector 40 are respectively turned on.

Based upon output signals from the holder position sensor 24A and 24B, it is judged whether or not the holder 1 is in its counting position. In the case where the holder 1 is in its standby position, the holder motor 23 is driven so as to move the holder 1 to its counting position.

Then, the pump motor 21 is driven to actuate the vacuum pump 8 and, at the same time, the count motor 19 is driven to rotate the rotary cylinder 3 clockwise, whereby one of the suction heads 5 is moved from the its standby position to its starting position.

When one of the suction heads 5 is in its starting position, the vacuum pressure within the suction pipeline 7

rises and when the suction head 5 is moved to its standby position, the vacuum pump 8 is communicated with the inside of the suction head 5 and the vacuum pressure acts on the bill S. Whether the one of the suction heads 5 is in its standby position or the starting position is detected by rotary cylinder position sensor 13. More specifically, if the rotary cylinder position sensor 18 detects the actuating piece 17, it is judged that one of the suction heads 5 is in its standby position and, on the other hand, if the rotary cylinder position sensor 18 does not detect the actuating piece 17, it is judged that one of the suction heads 5 is in its starting position.

In the case where one of the suction heads 5 is in its starting position, when the vacuum sensor 11 detects that the vacuum pressure inside of the vacuum pipe line 7 has risen to a predetermined pressure level, the count motor 19 is actuated so as to rotate the rotary cylinder 3 counter-clockwise while the suction heads 5 are rotated clockwise about the shafts 6. Then, at the time when one of the suction heads 5 is moved from its starting position to its standby position, the suction head 5 sucks the uppermost bill Sb and turns it over as the rotary cylinder 3 and the suction head 5 are rotated further. At the time when the bill turned over by one of the suction heads 5 reaches the position Sa, the next suction head 5 has sucked the next upmost bill Sb. All of the bills stacked in the holder 1 are turned over by repeating the same operation.

On the other hand, at the time when the suction head 5

is moved to its standby position, the count controlling circuit 45 outputs a trigger signal TRG to the discrimination controlling circuit 46 and the discriminating operation is started for the bill Sb which is about to be turned over by the suction head 5.

When the trigger signal TRG is input, the projector 40 emits a ray of light onto the surface in the area E of the bill Sb and the area sensor 34 photoelectrically detects the reflected light by the surface of the bill Sb. As described above, the area sensor 34 scans the specified portion on the surface in the area E of the bill Sb on a point-by-point basis and reads out the surface patterns thereof, thereby writing them in the RAM 65 via the A/D converter 73.

Then, the surface patterns of the specified portion in the area E written in the RAM 65 are compared with reference surface patterns stored in the ROM 64 to discriminate the denomination and the side of the bill Sb. The number of the reference surface patterns stored is equal to 4L, where L is the number of bill denominations and four patterns are stored for each denomination of bills: obverse side pattern, reverse side pattern, right-side-up pattern and up-side-down pattern. For the first bill the surface pattern thereof is compared with 4L reference surface patterns.

In the case where the surface patterns read out accords with one of the reference surface patterns stored and the bill Sb is the first one, the denomination code and the obverse/reverse side code of the bill Sb are written in the

RAM 65, and at each of further cycles judgment is made as to whether or not the surface pattern of the bill to be discriminated accords with one of the stored reference surface patterns of the denomination code of the first bill. When the surface pattern of a bill does not accord with any of the surface patterns of the denomination of the first bill stored in the ROM 64, it is judged that the bill denomination is different from that of the first bill and a different denomination code is written in the RAM 65. Further, even if the denomination of the bill accords with that of the first bill, when the surface pattern of the bill does not accord with that of the obverse/reverse side code of the first bill, a side discord code is written in the RAM 65.

On the contrary, in the case where the surface pattern read out for the first bill does not accord with any reference surface patterns stored, it is judged that the bill is abnormal, for example, the bill is foreign or forged and an abnormal code is written in the RAM 65, and at further cycles, 4L reference surface patterns are selected for discrimination of bills up to and including the first identified bill the surface pattern of which accords with one of the reference surface patterns stored in the ROM 64 and the first identified bill is deemed as the first bill and the above described operation is repeated.

Further, when the bill to be discriminated reaches the position Sa, double feed is discriminated. More specifically, since the denomination and the obverse/reverse of the bill have been discriminated and the discrimination results

have been written in the RAM 65 by this time, a double feed reference level for discriminating the double feed is selected, based upon the discrimination results, from among those stored in the ROM 64 and written in the RAM 65.

Thus, the lamp 37 emits a ray of light onto the surface of the bill Sa and the light transmitted through the bill Sa is collected to the light receiving element 38 by the condenser lens 39 and the amount of the transmitted light is photoelectrically detected thereby. The obtained electrical signal representing the detected amount of the transmitted light is converted to digital signals by the A/D converter 73 and written in the RAM 65. In the RAM 65, the detected amount of transmitted light is compared with the reference level for discriminating double feed, which was written in the RAM 65 and judgment is made as to whether or not the double feed has occurred. In the case where double feed has occurred, a double feed code is written in the RAM 65.

In the operation described above, in cases where at least one of the different denomination code, the side discord code, the abnormal code and the double feed code is written in the RAM 65, the discrimination controlling circuit 46 outputs an error signal to the count controlling circuit 45 and the error code is written in the RAM 48 of the count controlling circuit 45. In the case where the error code is written in the RAM 48, as in the batch mode, the counting operation for bills is stopped by urging the

separator 25 onto surface of the bill Sb which is about to be turned over by the suction heads 5.

On the other hand, in the case where the error signal is not output and the error code is not written in the RAM 48, the above operation is repeated until the counting and the discrimination of all bills stacked in the holder 1 are completed.

Figures 5 to 9 show examples of flow chart for effecting the above described operation of the discriminating apparatus in conjunction with the operation of the bill counting machine. It should be noted that Si in Figure 5 denotes the step i and Tj in Figure 9 denotes the timing Tj.

(A) Count controlling operation 1 (refer to Figures 5 to 9)

(Step 1)

Power is turned ON.

(Step 2)

Judgment is made based on output signals from the holder position sensor 24A, 24B as to whether or not the holder is in its standby position. In the case of NO, the holder motor 23 is driven to set the holder 1 in its standby position (Step 3). In the case of YES, the operation proceeds to the next Step 4.

(Step 4)

Judgment is made from the output of the rotary cylinder position sensor 18 as to whether or not one of the suction heads 5 is in its standby position. In the case of NO, the counting motor 19 is driven to move slowly the suction head 5 to its standby position (Step 5). In the case

of YES, the operation proceeds to the next Step 6.

(Step 6)

Judgment is made as to whether or not one or more mode switches 53, 54 and 55 has been turned ON by the operator. In the case of YES, the corresponding modes are written in the RAM 65 of the discrimination controlling circuit 46 and the RAM 48 of the count controlling circuit 45 (Step 50). In the case of NO, the operation proceeds to the next Step 7.

(Step 7)

Judgment is made as to whether or not a start signal has been issued from the start switch 52. In the case of NO, the operation returns to the preceeding Step 6. In the case of YES, the operation proceeds to the next Step 8 (Timing T1).

(Step 8)

Judgment is made as to whether or not the first switch 53 is turned ON. In the case of YES, the lamp 37 and the projector 40 are turned ON (Step 9). In the case of NO, the operation proceeds to the next Step 10 to start the counting operation.

(Step 10)

Judgment is made on the basis of the output of the holder position sensors 24A and 24B as to whether or not the holder 1 is in its counting position. In the case of NO, a holder motor driving signal HMD is output and the holder motor 23 is driven to set the holder 1 in its counting position (Step 11), and, in the case of YES, the operation

proceeds to the next Step 12 (Timing T2).

(Step 12)

A pump motor driving signal PMP is output to drive the pump motor 21, and a solenoid valve driving signal SV is output to change over the solenoid valve 16 to the exhaust nozzle 14.

(Step 13)

Judgment is made as to whether or not the suction heads 5 are in their start position. In the case of NO, a count motor driving signal CMD is output and the count motor 19 is driven in the reverse direction at a low speed to set the suction heads 5 in their start position (Step 14), and, in the case of YES, the operation proceeds to the next step (Timing T3).

(Step 15)

Judgment is made as to whether or not a pressure signal VSW has been output, namely, whether or not the negative pressure inside the suction pipeline 7 has risen to a predetermined level. In the case of NO, judgment is made as to whether or not a predetermined time (the time required for a rise in negative pressure) has lapsed from the timing T3 (Step 16). In the case of NO in this Step 16, the operation returns to the Step 15, and, in the case of YES in Step 16, the operation proceeds to a faulty suction processing route (shown by a dotted line in Figure 5) which will be described later.

On the other hand, in the case of YES in Step 15, the operation proceeds to the next Step 17 (Timing T4).

(Step 17)

When the pressure signal VSW is output (Step 15), the count motor driving signal CMD is output, whereby the rotary cylinder 3 and the suction heads 5 start rotating.

(Step 18)

Counting is effected as the suction head 5 turns over bills one by one. Each time the rotary cylinder position sensor 18 issues a signal SNS, a trigger signal TRG for reading the output of the area image sensor 42 is output. At the same time with the exception of the timing T5, a count signal CNT is output to effect the bill counting and, if the first mode switch 53 or the first and second mode switches 53 and 54 are turned ON, the discriminating operation is also effected. (Timings T5 to Tm)

(Step 19)

Judgment is made as to whether or not the pressure signal VSW is output. In the case where the pressure signal VSW is not output, it is judged that there is no bill to be turned over and that the negative pressure inside the suction pipeline 7 cannot rise (Timing Tm+1), and the operation proceeds to the next Step 20.

(Step 20)

The count motor 19 and the pump motor 21 are stopped.

(Step 21)

When the rotation of the rotary cylinder 3 is stopped in the preceding Step 20, judgement is made as to whether or not a driving signal (holder opening signal) for moving the

holder 1 to the standby position has been output. In the case of YES, the operation returns to the Step 2 (Timing Tn), and, in the case of NO, the operation stands by at this Step 21. In the case where the operation returns to the Step 2, judgment is made as to whether or not the holder 1 is in its standby position and a holder motor driving signal HMD continues to be output until the holder 1 assumes in its standby position.

When the holder 1 reaches in its standby position (Step 4; Timing Tn+1), the holder motor driving signal HMD is turned OFF and, at the same time, the count motor driving signal is output, thereby to drive the count motor 19. When the suction heads 5 have been moved to their standby position by the count motor 19, the ON output of the rotary cylinder position sensor 18 is issued, and, at the same time, the count motor is stopped (Timing Tn+2).

When the suction heads 5 are thus stopped in their standby position, the preparation has been completed and a further counting operation can be started by an ensuing start signal (Step 7).

Next, description will be made of the faulty suction processing route C.

In cases where it is impossible for the rotary cylinder 3 to stop at its predetermined position due to such causes as malfunctioning of the braking operation of the count motor 19, the inside of the suction pipeline 7 is not sealed from the outside, so that the negative pressure fails to rise even after more than a fixed time has lapsed. There-

fore, the pressure signal VSW cannot be output (Step 16).

In such a case, the count motor 19 is rotated reversely at a low speed, the position of the rotary cylinder 3 is adjusted (Step 30), and the Steps 13 to 15 are repeated. Furthermore, in a case where the vacuum pressure fails to rise even after repeating this operation K times (Step 31), the pump motor 21 is stopped (Step 32), an alarm signal is output (Step 33) to the indicator unit 63, and then, the machine is stopped (Step 34).

Next, referring to Figure 6, description will be made of the count controlling operation effected in the CPU 49, and referring to Figures 7 and 8, description will be made of the discrimination controlling operation effected in the CPU 49.

(B) Count controlling operation 2 (refer to Figure 6)

(Step 100)

The machine is started.

(Step 101)

Judgment is made as to whether or not the first mode switch 53 is ON, namely, whether or not it is necessary to read the pattern of the bill surface for discriminating the denomination thereof. In the case of YES, a discrimination instruction signal and, if the second mode switch 54 is also ON, an obverse/reverse mode instruction signal are output (Step 102), and they are fed into the flow chart shown in Figure 7 as indicated by Z1.

On the contrary, in the case where the first mode

switch 53 is OFF, it is judged that only counting should be effected and the operation proceeds to the next Step 103.

(Step 103)

The presence of the rise of an output signal SNS of the rotary cylinder position sensor 18 is detected and if its presence is detected, the operation proceeds to the next Step 104.

(Step 104)

At the timing of Step 103, the trigger signal TRG is raised and the output of the trigger signal TRG is fed into the flow chart shown in Figure 7 as indicated by 22.

(Step 105)

Judgment is made as to whether or not the output signal SNS of the rotary cylinder position sensor 18 is ON. In the case of YES, judgment is made as to whether or not the pressure signal VSW is ON (Step 106), and in the case of NO at Step 106, a discrimination prohibition signal is issued (Step 150) and the count motor 19 and the pump motor 21 are stopped and the lamp 37 and the projector 40 are turned off (Step 151). In the case of YES at Step 106, the operation proceeds to the next Step 107.

(Step 107)

Judgment is made as to whether or not the first mode switch 53 is ON. In the case of YES, the operation proceeds to Step 108 and in the case of NO, the operation proceeds to Step 109.

(Step 108)

Judgment is made as to whether or not it has been

judged that the denomination of the bill is different from that of a reference bill, that the side of the bill is reverse with respect to that of the reference bill when the second mode switch 54 is ON, that the bill is abnormal or that a double feed occurred, in other words, whether or not the error signal which is output from the discrimination controlling routine shown in Figure 7 as indicated by Z3 has been input. In the case of YES, the batch solenoid 28 is driven, thereby to stop the counting operation and in the case of NO, the operation proceeds to the next Step 109.

(Step 109)

Judgment is made as to whether or not the batch mode is ON. In the case of NO, the operation returns to Step 105 and in the case of YES, since the operator inputs an instruction that when the count of bills comes equal to the number of bills preset, the counting operation should be stopped, the operation proceeds to the next Step 110.

(Step 110)

The bill count is compared with the number of bills preset by the operator and judgment is made as to whether the bill count is equal to the preset number of bills. In the case of NO, namely, where the count of bills is less than the predetermined number of bills, the operation returns to the Step 105. On the contrary, in the case of YES, the batch solenoid is turned ON to actuate the separator 25 and after the counted bills are separated from uncounted bills (Step 111), the discrimination prohibition signal

which is fed into the discrimination controlling routine shown in Figure 7 as indicated by Z1 is output (Step 112), whereby the count motor 19 and the pump motor 21 are stopped and the lamp 37 and the projector 40 are turned OFF (Step 113). Then, the operation proceeds to the next Step 114.

(Step 114)

Judgment is made as to whether or not the actuation of the separator 25 is released and in the case of YES, the operation proceeds to the next Step 115.

(Step 115)

The driving signal (holder opening signal) for moving the holder 1 to its standby position (refer to the Step 21) is output to the holder motor 23 and the operation is completed.

Next, description will be made of Steps 120 to 121.

(Step 120)

At the previous Step 105, if the output signal SNS of the rotary cylinder position sensor 18 has been ON, the Steps 105 to 109 (or 110) are repeated and at the time when the signal SNS turns OFF, the operation proceeds to this Step 120.

Then, similarly to Step 106, judgment is made as to whether or not the pressure signal VSW has been turned ON. In the case of NO, the operation proceeds to Step 150 and the discrimination prohibition signal is output (Step 150), whereby the count motor 19 and the pump motor 21 are stopped and the lamp 37 and the projector 40 are turned OFF (Step

151).

On the contrary, in the case of YES, the operation proceeds to the next Step 121.

(Step 121)

Judgment is made again as to whether the output signal SNS of the rotary cylinder position sensor 18 is ON. In the case of NO, the operation returns to Step 120. On the contrary, in the case of YES, the trigger signal TRG is output and it is fed into the discrimination controlling routine shown in Figure 7 as indicated by Z2 (Step 122) and after the count has been increased by one (Step 123), the operation returns to Step 105.

Further, description will be made of Steps 150 to 165.

(Step 150)

At Steps 106 and 120, in the case where the pressure signal VSW has not been issued, namely, when one of the suction heads 5 is its standby position and a bill has not been sucked or there is no bill to be counted, the discrimination prohibition signal is output, whereby the count motor 19 and the pump motor 21 are stopped, and the lamp 37 and the projector 40 are turned off (Step 151) whereafter the operation proceeds to the next Step 152.

(Step 152)

Judgment is made as to whether the first mode switch 53 is ON. In the case of NO, the operation proceeds to Step 160 and in the case of YES, the operation proceeds to Step 153.

(Step 153)

In a case where, up to the time a predetermined time period has lapsed (Step 154), the discrimination controlling routine shown in Figure 7 issues no end signal of the kind issued when a patternless surface is detected as indicated by Z4, for example, where although bills to be counted have been set, a bill is not sucked, a code (bill remaining code) for showing that there are remaining bills is written in a predetermined portion of the RAM 48 (Step 155), and, then, the operation proceeds to Step 114.

On the other hand, in the case where the end signal is output from the discrimination controlling routine, the operation proceeds to the next Step 160.

(Step 160)

Judgment is made as to whether or not a count check mode has been set. In the case of NO, the operation proceeds to Step 164 and in the case of YES, the operation proceeds to Step 161.

(Step 161)

Judgment is made as to whether or not a count obtained by counting bills accords with the value predetermined by the count check mode. In the case of NO, a code (count discord code) for showing discord of counting is written in a predetermined area of the RAM 48 (Step 166) and, then, the operation proceeds to Step 114. On the contrary, in the case of YES, the operation proceeds to the next Step 162.

(Step 162)

Judgment is made as to whether or not a stamp mode has

been set. In the case of YES, the stamp solenoid 35 is actuated and the wrapper B is stamped (Step 163) and in the case of NO, the operation proceeds to Step 164.

(Step 164)

Judgment is made as to whether or not an addition mode is set. In the case of YES, the sum of the bill count obtained by counting bills in the previous cycles is added to the bill count obtained by counting bills in the current cycle and the new sum of the bill count obtained by the addition is stored in the RAM 48. On the other hand, in the case of NO, the operation proceeds to Step 115. Thus, the counting operation is completed.

Next, description will be made of a discriminating operation in the CPU 66 referring to Figures 7, 8 and 10.

(Step 200)

The operation is started.

(Step 201)

Judgment is made as to whether or not the trigger signal TRG indicated by Z2 is output from the count controlling routine. In the case of YES, the operation proceeds to the next Step 202.

(Step 202)

Judgment is made as to whether or not the discrimination instruction signal indicated by Z1 is output from the count controlling routine. In the case of NO, the operation returns to Step 201. On the contrary, in the case of YES, the analog switch 80 shown in Figure 4 is selected, whereby

the outputs of the double feed detecting sensor 37 and 38 are fed to the RAM 65 via the amplifier 78 and the A/D converter 73 and stored therein (Step 203), and then the operation proceeds to Step 204.

(Step 204)

Based upon error codes set at Steps 214, 222 and 232, respective judgment is made as to whether or not a bill having a different denomination from that of the reference bill is mixed in, whether or not a bill whose side is different from that of the reference bill is mixed in and whether or not a different kind of a bill is mixed in. (These discrimination will be described in detail at Steps 213, 221 and 231.) In the case of YES for one of the judgments, an error signal and the error code are output and the nature of the error is displayed on the indicator unit 63 (Step 205), and then the operation returns to Step 201. Simultaneously, the error signal is fed to Step 108 of the count controlling routine shown in Figure 6 as indicated by Z3.

On the contrary, in the case of NO, the operation proceeds to Step 206.

In this connection, when the trigger signal TRG is first output, since the operation at Steps 214, 222 and 232 have not been effected and no discriminations are effected, the operation at Step 204 always proceeds to Step 206 the first time.

(Step 206)

Based upon the detected data input from the double

feed detecting sensor 37 and 38 and reference double feed levels set at Step 217 which will be described in detail later, judgment is made as to whether or not two or more bills are fed at one time. In the case of YES, the error signal and the error code are issued and the nature of the error is displayed on the indicator unit 63 (Step 207) and, then, the operation returns to Step 201. Simultaneously, the error signal output at Step 207 is fed to Step 108 of the count controlling routine shown in Figure 6 as indicated by Z3.

On the other hand, in the case of NO, the operation proceeds to Step 208.

Similarly to Step 204, when the trigger signal TRG is first output, since bills Sa are not present at a position shown in Figure 1 and the operation at Step 217 has not been effected and reference double feed level is not set yet, the operation always proceeds from Step 206 to Step 208.

(Step 208)

A surface pattern for representing data of N lines, such as at five lines selected in the area E, are input by selecting the analog switch 79 and feeding the output of the area sensor 34 to the RAM 65 one line at a time via the amplifier 72 and the A/D converter 73 and written in the RAM 65. The input of the surface pattern of the N lines to the RAM 65 is effected in accordance with the flow chart shown in Figure 8. More specifically, when an input instruction signal is issued (Step 300), the Y coordinate and X coordi-

nate are both set zero (Step 301) and then the operation proceeds to Step 302.

At Step 302, judgment is made as to whether or not the input of the surface pattern of the N lines has been completed. In the case of YES, a discrimination start signal is output (Step 303) and the operation returns to the main routine shown in Figure 7. On the contrary, in the case of NO, the operations at Steps 304 to 311 are repeated until the input of the surface pattern of the N lines has been completed and then the operation proceeds to Step 303.

After the input of the surface pattern of N lines has been completed, the operation proceeds to Step 209.

(Step 209)

Judgment is made as to whether or not the input surface pattern of N lines represents a patternless surface, that is, represents the pattern of the black back surface 1b of the holder 1. In the case of YES, the end signal is output (Step 210) and then the operation returns to Step 201. The end signal output at the Step 210 is also fed to Step 153 of the count controlling routine shown in Figure 6 as indicated by Z4.

On the other hand, in the case of NO, the operation proceeds to Step 211.

(Step 211)

Judgment is made as whether or not the sucked bill is the first one. In the case of YES, the operation proceeds to Step 212 and in the case of NO, the operation proceeds to Step 230.

(Step 212)

The surface pattern of the bill input at Step 208 is compared with the reference surface patterns stored in the ROM 64, the number of these patterns being equal to 4 x L patterns, where L is the number of bill denominations and four patterns are stored for each denomination of bills: obverse side pattern, reverse side pattern, right-side-up pattern and up-side-down pattern. The operation then proceeds to Step 213.

(Step 213)

Judgment is made as to whether or not the surface pattern of the bill accords with one of the reference surface patterns stored. In the case of NO, it is judged that the bill to be discriminated is an abnormal one and the abnormal code for showing that the bill is abnormal is written in a predetermined area of the RAM 65 (Step 214) and, then, the operation returns to Step 201.

On the contrary, in the case of YES, the denomination code for showing the denomination of the first bill is set (Step 215) in a predetermined area of the the RAM 65. Then, judgment is made as to whether the side of the bill is obverse or reverse and the obverse/reverse side code for showing that the side of the bill is obverse or reverse is set, namely, the obverse/reverse side code is written in the RAM 65 (Step 216). Further, based upon the result of the above discrimination, the reference double feed level for discriminating the double feed is read from the ROM 64 and

written in the RAM 65 (Step 217) and the operation proceeds to Step 218.

(Step 230)

On the other hand, in the case where it is judged that the bill sucked by the suction head 5 at the Step 211 is not the first one, the surface pattern of the bill input at Step 208 is compared with only the four reference patterns for the bill denomination of the first bill written in at Step 215 and the operation proceeds to Step 231.

(Step 231)

In the case where the surface pattern of the bill does not accord with any of the reference patterns of the first bill, it is judged that the denomination of the bill is different from that of the first bill written in at the Step 215 and a different denomination code for showing that the denomination of the bill is different is written in a predetermined area of the RAM 65 (Step 232) and, then, the operation returns to Step 201.

On the contrary, in the case where the surface pattern of the bill accords with one of the reference surface patterns of the first bill, judgment is made as to whether the side of the bill is obverse or reverse and the obverse/reverse side code for showing that the side of the bill is obverse or reverse is set in a predetermined area of the RAM 65 (Step 216) and, further, based upon the result of the above discrimination, the reference double feed level for discriminating the double feed is read from the ROM 64 and is written in a predetermined area of the RAM 65 and the

operation proceeds to Step 218.

(Step 218)

Judgment is made as to whether or not the second mode switch 54 is ON. In the case of NO, the operation returns to Step 201 and in the case of YES, the operation proceeds to Step 219.

(Step 219)

Judgement is made as to whether or not the bill is the first one. In the case of NO, the operation proceeds to Step 221 and in the case of YES, the operation proceeds to Step 220.

(Step 220)

The obverse/reverse code of the first bill for which the obverse/reverse side code was set at Step 216 is written in the RAM 65 as an obverse/reverse reference code and based upon the obverse/reverse reference code, the side of bills is discriminated (Step 221).

(Step 221)

Judgment is made as to whether or not the side of a bill other than the first bill accords with that of the first bill by comparing the obverse/reverse side code set at the Step 216 and the obverse/reverse reference code written in the RAM 65 at Step 220. In the case of YES, the operation returns to Step 201 and in the case of NO, the operation proceeds to Step 222. At Step 222, a side discord code for showing that the side of the bill does not accord with that of the first bill is set in a predetermined portion of the

RAM 65 and the operation of Steps 201 to 232 are repeated.

The timing of various operations such as the issuance of the trigger signal TRG are shown in a time chart of Figure 10.

More specifically, the trigger signal TRG is issued at the time of Step 201 (trigger signal timing), the light transmitted through the bill is detected and written in the RAM 65 at the time of Step 203 (double feed level storing timing), the error signal and the error code are generated at the time of Step 204 (error check timing), the double feed is discriminated at the time of Step 206 (double feed check timing), the surface pattern of the area E is input at the time of Step 208 (surface pattern input timing) and the completion of the discrimination is judged at the time of Step 209 (end check timing). Further, the discrimination is effected at the time of Steps 211 to 213, 230 and 231 (discrimination timing), and the discrimination results for the first bill are written in the RAM 65 at the time of Steps 215 to 217, 214, 222 and 232 (code set timing).

Since a surface pattern of the area E, that is, the surface patterns of a plurality of lines, is read out by the area image sensor 34 and is compared with the reference surface patterns stored in the ROM 64 for discriminating bills, two or more lines suitable for discriminating currencies can be easily selected in the area E and the discrimination accuracy can be remarkably improved.

Further, in case where other kinds of

currencies are to be discriminated, it is possible to effect the discrimination without adjusting the positions and/or directions of the lamp 37, the projector 40, the light receiving element 38 or the light receptor 41, or the design of the discriminating apparatus.

Furthermore, as shown in the time chart of Figure 9, in the above described discriminating apparatus, it takes more time to complete one cycle of the discrimination for the first bill (from T5 to T6), since the rotation of the rotary cylinder 3 does not reach the steady state immediately. So, the discrimination for the first bill is effected by comparing the surface pattern thereof with 4 x L reference surface patterns stored in the ROM 64 during this long cycle and since each cycle of the discrimination (from T6) is shorter for other bills, the discriminations for other bills are effected by comparing the surface pattern thereof with only four reference patterns of the denomination of the first bill by utilising the discrimination result for the first bill, whereby the time required for the discrimination can be considerably shortened.

Although the surface pattern of the first bill is compared with 4 x L reference surface patterns, while the surface pattern of other bills is compared with only four reference surface patterns of the denomination of the first bill, it is possible to compare the surface pattern of all bills with 4 x L reference surface patterns.

Although lines extending along the X axis are selected in the area E to read out the surface pattern thereof, lines extending along the Y axis may be

selected.

Although the area image sensor 34 is employed for reading out the surface pattern of the area E, a plurality of line image sensors may be employed in place of the area image sensor 34.

CLAIMS:

1. A discriminating apparatus for a bill counting machine comprising holder means for holding a stack of bills and suction head means for sucking the bills from the holder means and turning over the bills one by one, light projecting means for emitting a ray of light onto the specified area on the surface of the bill to be discriminated, read out means for receiving light reflected by the bill while the bill is turned over by the suction head means and reading out the surface pattern of a plurality of specified lines in the specified area of the bill, storing means for storing reference surface patterns of bills, and comparing means for reading out the reference surface patterns from the storing means and the surface pattern from the read out means and comparing the surface pattern read out from the read out means with the reference surface patterns.

2. A discriminating apparatus for a bill counting machine as claimed in Claim 1, wherein for each of L denominations of bills to be discriminated the storing means stores a right-side-up pattern and an up-side-down pattern for both the obverse and reverse sides of the bill, the total number of the reference surface patterns stored thus being 4L.

3. A discriminating apparatus for a bill counting machine as claimed in Claim 2, which further includes reference pattern selecting means for selecting reference surface patterns from among the reference surface patterns stored in the storing means in accordance with whether the bill to be discriminated is the first identified bill or not, all 4L reference

surface patterns being selected for discrimination of bills up to and including the first identified bill, and only the four reference surface patterns of the first identified bill being selected for the discrimination of the other bills, the reference pattern selecting means being adapted to output the selected reference patterns to the comparing means for the comparing means to read out and compare the reference surface patterns selected by the reference pattern selecting means and the surface pattern read out by the read out means.

4. A discriminating apparatus substantially as herein described with reference to and as shown in the accompanying drawings.

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